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A MAGAZINE OF METHODS FOR OPERATING MEN

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Meetings

American Association of Petroleum Geologists—March 21, 22 and 23, Wichita, Kansas.

California Natural Gasoline Association, Monthly Meeting—April 4, Richfield Building, Los Angeles.

Oil Equipment and Engineering Exposition—April 8, 9, 10, 11, 12, and 13, Houston, Texas.

Petroleum Industry Electrical Association—April 11, 12 and 13, Baker Hotel, Dallas, Texas.

Natural Gasoline Association of America—May 1, 2 and 3, Tulsa Hotel, Tulsa, Oklahoma.

American Gas Association, Natural Gas Department, Annual Convention—May 6, 7, 8, and 9, Hotel Peabody, Memphis, Tennessee.

American Petroleum Institute, Fifth Mid-Year Meeting—May 14, 15 and 16, Mayo Hotel, Tulsa, Oklahoma.

Pennsylvania Grade Crude Oil Association, Annual Meeting—June 20 and 21, State College, Pennsylvania.

American Society for Testing Materials, Annual Meeting—June 24, 25, 26, 27 and 28, Book Cadillac Hotel, Detroit, Michigan.

Independent Petroleum Association of America, Annual Meeting—November 4 and 5, Adolphus and Baker hotels, Dallas, Texas.

American Petroleum Institute, Sixteenth Annual Meeting—November 11, 12, 13, and 14, Biltmore Hotel, Los Angeles, California.

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The Course of Oil

By K. C. SCLATER

Modifying a Sand's Permeability

Among the many excellent papers read at the A. I. M. E. yearly meeting in New York last month was one on experimental work conducted at the University of California, one of the main objects of which was to investigate the resistance that wells of small diameter offer to the flow of fluids into the hole. All the evidence obtained in the laboratory shows that the resistance to flow is tremendous. As the fluids approach the well through the sand, the area through which they must flow rapidly becomes smaller. This rapid decrease of area, which reaches a maximum at a point immediately adjacent to the wall of the hole, has been termed the "keystoning" effect. This is not all. As the fluids flow through the highly restricted area in the vicinity of the well a reduction of pressure occurs, the amount of reduction depending on the rate of flow. This causes the fluids to expand, and the increase in volume resulting aggravates the conditions retarding flow already set up in the sand in the immediate vicinity of the hole.

Enlarging the diameter of the hole is suggested by the authors of the paper as a means of overcoming the difficulty.

There is ample evidence in actual field practice to support the laboratory findings of these investigators. They adduce evidence to emphasize a very important point in production practice.

Continuing along a similar line of thought, the writer of this column should like to point out that the same ends as sought and advocated by these investigators are being successfully achieved in actual practice, although by different means.

Some time ago in this column the fact was brought out that the development of new practices in the industry might, overnight, change many of our conceptions on matters of development. An example was cited of how the well-spacing problem might be profoundly affected by controlled directional drilling.

Now along comes another development that may be equally potent in influencing the well-spacing problem. This time it is the practice, recently developed, of perforating well casing and oil sands with a gun perforator. By use of this device the sand surrounding the well can be perforated; channels can be artificially made to allow the oil to drain more freely into the hole. The so-called "keystoning" effect may no longer be a problem if the permeability of the sand in the immediate vicinity of the bore-hole can, in effect, be altered. In other words, modern science has made another step toward modifying what, not so long ago, was thought to be unalterable.

What can be and actually is being done today in this connection is really tantamount to increasing to any desired degree the permeability of the producing sand in the vicinity of the well. The gun perforator, the significance of which perhaps is not yet fully appreciated, does it. It is a development revolutionary in its scope because it can be applied to change the natural fundamental characteristics of a well's flow.

Bullets from the perforator gun can be made to penetrate the producing horizon from three to eight feet at any desired point. Each bullet leaves in its path a clean hole about a half-inch in diameter; a hole that serves as a radial channel in the sand through which the oil and gas can flow with ease into the hole. In effect, the permeability of the sand surrounding the well is increased.

Perhaps the most important point of this development lies in the fact that the natural permeability of the sand, heretofore considered fixed and unalterable, may be modified to any desired degree in the immediate vicinity of the well. The extreme importanc of the permeability of the sand at this point has been brought out by laboratory investigation. Modifying the permeability of the sand in this manner will have some influence on the drainage area of the well and hence will have an effect on well-spacing. Moreover, who can tell what further development tomorrow will bring forth? It is not unreasonable to anticipate that much greater penetration of the sand will be possible in the future. When that day comes, it may be that much of the theory on the flow of oil and gas through sands will be thrown into the discard.

Another means of achieving similar results, though in a much more restricted sense, is the treating of wells with acid. This method at the present time is practically limited to limestone producing strata. The day may not be so far distant when acid treatment will be applicable to any type of formation.

In this particular phase of development, it would seem that the oil industry, in its pursuit of more efficient producing methods, is on the eve of removing another of Nature's obstacles lying in the path of economic oil recovery.

Taxation and Physical Waste

Higher taxation on industry seems to be the order of the day and oil and its products, despite the heavy tax burden they already carry, are not being left out of consideration. Much is heard in certain states, particularly Texas and Oklahoma, regarding physical waste and saving the small stripper wells of the country. Perhaps for the moment the fact has been entirely lost sight of that higher taxes on crude production may actually tend to create physical waste by causing small wells to be prematurely abandoned.

A tax on crude production means an increase in lifting cost, and an increase in lifting cost shortens the economic life of the well. Many small wells of the stripper class cannot afford to have their economic life shortened without grave consequences. They must be shut down or abandoned.

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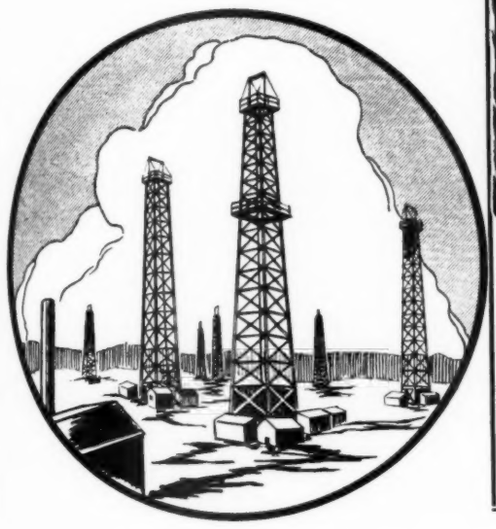

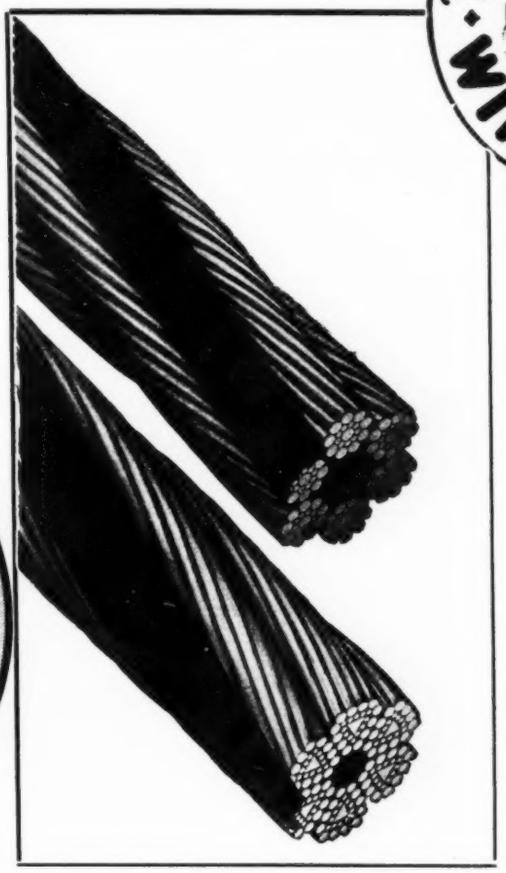

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« « « HIGHLIGHTS IN OILDOM » » »

Pressure Decline in East Texas

Tests made in the East Texas field early in March revealed that the average bottom-hole pressure decline was six lb. during February. Certain of the key wells had pressure declines as great as 35 to 40 lb.; however, these instances were exceptional and were attributed to local conditions. The weighted average reservoir pressure for the entire producing structure was announced as 1221 lb. on March 1.

Consideration of monthly fluctuations in pressure for East Texas are interesting. During December the average weighted pressure showed an increase of ten lb., and in January it declined four pounds. The average pressure on February 1, 1935, was seven lb. greater than the average on July 1, 1933. Even with the pressure decline of six lb. during February it still is approximately 40 lb. above what is considered normal, despite the fact that 700 million bbl. of crude have been taken from the field.

•

Cementing Rule Revised

The Texas Railroad Commission has revised its cementing rule applicable to the East Texas field in order to permit a two-stage cement job. The revised rule reads as follows:

"Rule 2. A minimum of 100 ft. of surface casing shall be run and cemented with at least 30 sacks of quick-set cement for 10-in. casing, and 50 sacks for 12½-in. casing. Cement shall be allowed to set a minimum of 12 hours before drilling plug."

•

Kansas Potential Reaches High Mark

Figures contained in the March allocation order issued by the Kansas Corporation Commission from the office of Theo. A. Morgan, oil umpire, reveal that the state has attained its greatest production potential. The 19,486 wells have a capacity of 472,438 barrels. Coincident with the largest potential in the state's history, Kansas was given its largest crude allowable, 139,700 bbl. daily, effective March 1.

The oil umpire, on February 1, reported a total of 19,430 wells with a potential of 429,652 bbl. The March 1 report represents a gain of 56 producers, and in production 42,786 barrels.

Virtually all the new production is from the western part of the state where drilling is exceptionally active. The Kansas oil industry is experiencing its greatest activity since 1929. Since January 1 a total of 237 new operations have been started.

•

Well Completed Under Another Lease Held Trespassing

A decision of importance has been handed down by Superior Court Judge Percy Hight at Long Beach, California, in the case of the Union Oil Company of California vs. the Reconstruction Oil Company. Suit was instituted against the latter firm over a well drilled near the Union Oil Company's Long Beach Community lease, the charge being that the well was diverted so the bottom was under the Union's property. Judge Hight's decision was that a well drilled thus under another company's lease is clearly a case of trespassing, the operators of the well can be properly enjoined from producing it, and recovery can be had for all oil removed. The defendant was ordered to plug the well at the point where it crossed the lease line, and restraining orders were issued.

•

Oklahoma City Drilling Zone Extended

Residents of Oklahoma City, on March 5, voted to extend the drilling zone for oil two miles to the north, thus ending a controversy of several months' duration. The new zone embraces more than 3000 business houses, residences, churches, and school buildings, and affects a population of approximately 25,000 persons.

•

West Texas Holds Deep Drilling Record

Texas again is the holder of drilling depth honors. Early this month the Gulf Production Company's No. 103 J. T. McElroy, Upton County, West Texas, had been drilled to a depth of 11,410 ft., passing the previous record held by the General Petroleum Corporation's No. 1 Berry in the South Belridge field, California, which is producing from a total depth of 11,377 feet. A hole 6⅛ in. in diameter is being cut, the crew carrying open hole below 10,301 ft., where 7⅝-in. casing was cemented last July. The last bottom-hole temperature reading was taken at a depth of 10,630 ft., recording 150 deg. fahrenheit.

•

Connally Bill is Enacted

The Connally Bill, designed to eliminate illegally-produced oil from interstate commerce, has been passed by both branches of Congress and signed by President Roosevelt.

The new law makes the interstate shipment of "hot oil" a violation of the federal statutes; authorizes the president to lift prohibition of interstate movement of such crude if he finds a disparity between supply and demand; and calls for federal confiscation of such petroleum taken across a state line.

The legislation will terminate June 16, 1937, the day the National Recovery Act will expire if President Roosevelt's request for a two-year extension is granted.

•

U. S. Oil Tender Board Revived

An executive order has been signed by President Franklin D. Roosevelt reviving the federal tender board, an agency for regulation of interstate oil shipments out of Texas, under authority of the Connally Act.

The oil administrator, Secretary Ickes, reappointed the three former members of the board, Norman L. Meyers, M. S. McCorquodale, and John F. Davis, all of whom already were in the East Texas field. The federal tender board was dissolved following the recent decision of the United States Supreme Court holding illegal Section 9-C of the recovery act. The newly-appointed board began functioning immediately.

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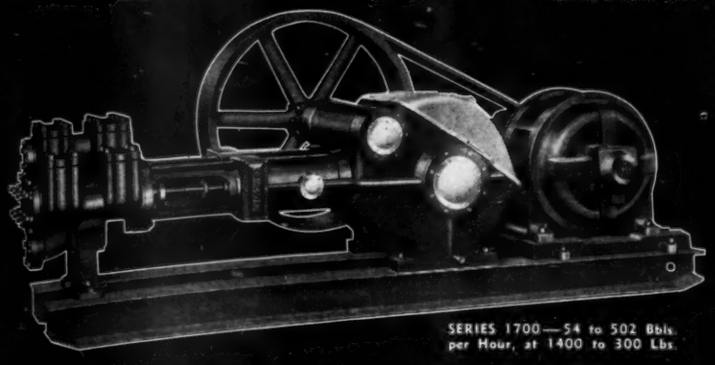
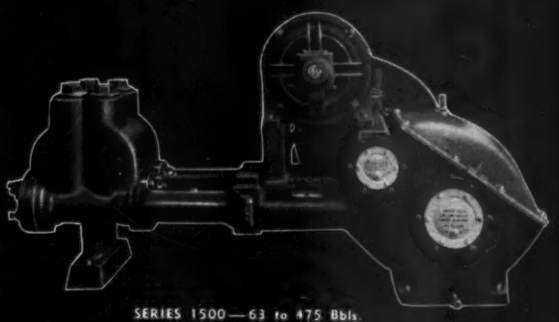


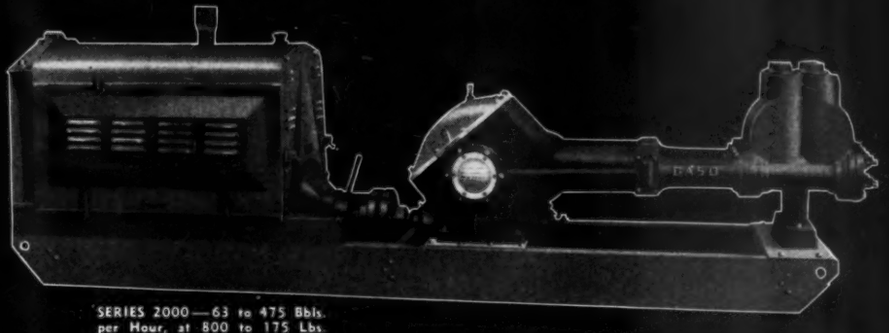
SERIES 1700—54 to 502 Bbls. per Hour, at 1400 to 300 Lbs.



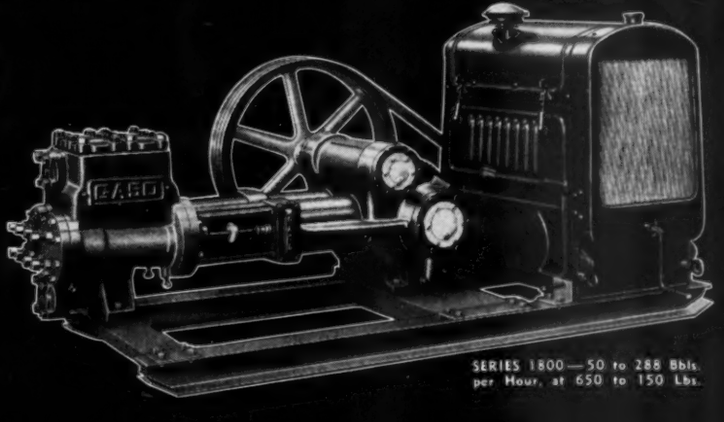
SERIES 1500—63 to 475 Bbls. per Hour, at 800 to 175 Lbs.

FIG. 601 —Walking Beam Pump, 10 to 55 Bbls. per Hour

FIG. 604 — For Gas or Vacuum, 26 to 28 Points Vacuum, 14" to 20" Cyl.



SERIES 2000—63 to 475 Bbls. per Hour, at 800 to 175 Lbs.



SERIES 1800—50 to 288 Bbls. per Hour, at 650 to 150 Lbs.

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FIG. 201 — Radline Pump, 31 to 41 Bbls. per Hour

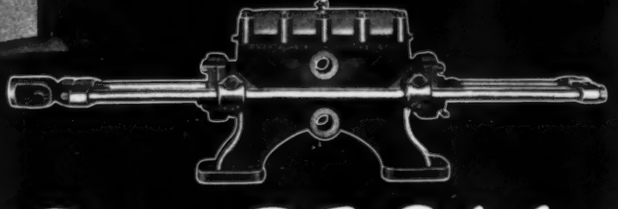

FIG. 301 — Jerker Pump, 32 to 157 Bbls. per Hour

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LATEST ACTIVITIES IN THE OIL FIELDS

THE Russell field of Russell County, Kansas, has been extended a mile to the south by Louis Winkler's and Fred Koch's No. 1 J. R. Freed Estate. On its initial test the well made ten bbl. per hour from the Siliceous lime at a total depth of 3311 feet.

•

Rush County, Kansas, is getting its biggest play since oil was discovered in the western part of the state ten years ago. Land and lease men are combing the area, buying up all available acreage. Interest in that county has been heightened by the finding of oil both in the Wakeeny area of Trego County and in western Barton County near the town of Albert, bordering the Rush County line. Numerous wildcat locations have been staked in the area.

•

The Wildcat gasser of the Gulf Production Company on the Camp Hill structure of southwestern Anderson County, Texas, has developed a flow of 54 gravity oil, making approximately 40 bbl. daily, thus adding weight to the belief that the area has prospects of becoming an important find of the current year.

•

Two new shallow pools were recently opened in Texas, one near the west line of Shackelford County, the other a mile northwest of the original South Vernon field in Wilbarger County. Jones, Stasney and the Reliance Oil and Royalty Corporation's No. 1 G. R. Davis opened the Shackelford County pool, pumping 30 bbl. per day from sand at a total depth of 1607 feet. Opening of the pool in Wilbarger County is credited to Lawson and Leawell's No. 1 Waggoner Estate, rated at from 50 to 75 bbl. daily. The well is producing from sand at 1649-1651 feet.

•

The Gulf Production Company's No. 103 McElroy in western Upton County, West Texas, now has the distinction of being the world's deepest test. Latest reports have the test drilling below 11,410 feet. Previously the depth record was held by the General Petroleum Corporation's No. 1 Berry in the South Belridge field, California, which is bottomed at 11,377 feet. The latter is a producing well.

•

The Long Beach field, although discovered 14 years ago, is the most active spot in California. During 1934 a total of 83 completions was reported. Many new locations have been staked since the first of the current year and many operators believe that 1934's total number of completions will be surpassed by those of 1935. The greatest recent activity has been on the south flank of the field, where the wells are being completed at the comparatively shallow depth of 4200 to 4500 feet. The wells make a flush production of from 250 to 1000 bbl. a day.

•

A new oil-producing area was opened in New Mexico when the Amerada Petroleum Corporation's State 1-D, the first test to be made on the Monument structure, was bought in a commercial producer. First production was from lime formation at a total depth of 3895 ft., but the hole later was deepened to 3954 feet. On a recent test the well made 324 bbl. of 32 gravity oil in 12 hours.

•

The Universal Consolidated Oil Company's N-2, credited with having located a new field near Montebello, in Los Angeles County, California, has proved to be somewhat of a disappointment. Certain operators now think it may be an edge well of the so-called new field. Having stopped flowing, the well has been placed on the pump, and is producing 130 bbl. of 35.6 gravity oil daily, accompanied by an occasional slug of mud.

•

Prospects of an extensive Siliceous lime pool in the Hominy district of Osage County, Oklahoma, is seen as a possibility with the Bay Oil Corporation bringing in a producer from that formation. The test was drilled to a total depth of 2952 ft., but was plugged back to 2934 ft., acidized, and produced 758 bbl. in 14 hours through casing. After 2-in. tubing was run it flowed 20 bbl. per hour.

AVERAGE CRUDE OIL PRICES

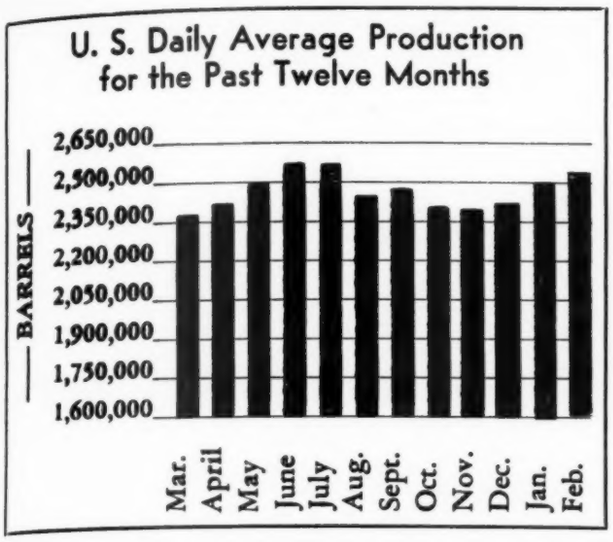
California		Louisiana	
Playa Del Rey	$ .90	North Louisiana	$ .95
Coalinga	.81	Gulf Coast	1.04
Signal Hill	1.12	Illinois	1.13
Montana	1.35	Kentucky	1.08
Wyoming	1.00	Indiana	1.12
Colorado	1.00	Ohio	
New Mexico	.75	Lima	1.30
Texas		Michigan	1.02
North Central	.95	Pennsylvania	
Panhandle	.51-.71	Bradford	2.35
West Texas	.70-.75	Southwest	2.02
Gulf Coast	1.04	Eureka	1.97
Darst Creek	.87	Buckeye	1.87
East Texas	1.00	Corning	1.32
Kansas	1.00	West Virginia	1.67
Oklahoma	1.00	Canada	2.10-2.17
Arkansas	.70		

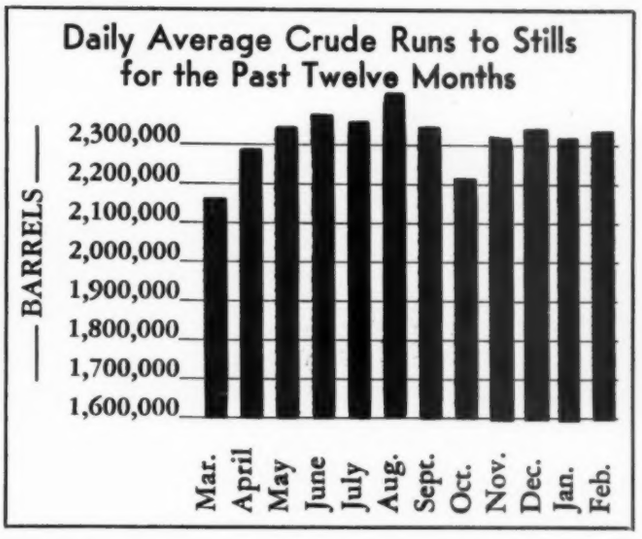
DAILY AVERAGE CRUDE OIL PRODUCTION

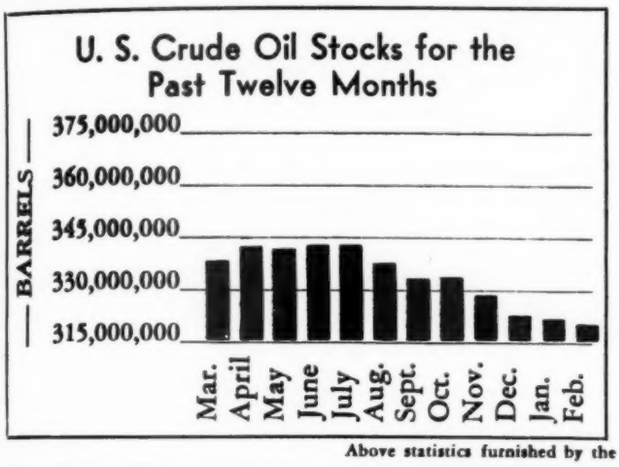
(Figures in barrels)

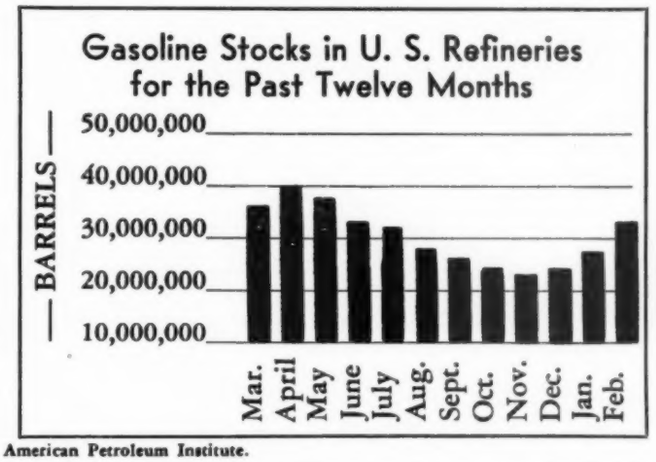
Furnished by A.P.I.

	Federal Agency Allowable Effective March 1	Week Ended March 2, 1935	Week Ended Jan. 26 1935	Week Ended March 3, 1934
Oklahoma	491,000	457,800	509,950	404,550
Kansas	139,700	146,400	141,000	113,100
Panhandle Texas		62,850	60,900	57,700
North Texas		57,550	56,750	55,150
West Central Texas		25,650	26,050	26,800
West Texas		150,300	153,950	128,950
East Central Texas		51,250	51,500	43,100
East Texas		438,300	427,800	416,850
Conroe		47,200	47,600	49,200
Southwest Texas		59,900	57,850	45,450
Coastal Texas (Not incl. Conroe)		129,850	127,900	111,550
TOTAL TEXAS	1,020,100	1,022,850	1,010,300	934,750
North Louisiana		23,000	23,200	27,650
Coastal Louisiana		94,400	88,550	44,200
TOTAL LOUISIANA	110,500	117,400	111,750	71,850
Arkansas	31,900	30,050	31,400	30,950
Eastern (Not incl. Michigan)	105,500	106,550	99,400	88,500
Michigan	31,600	33,350	34,650	29,750
Wyoming	35,100	31,400	33,200	31,050
Montana	9,500	10,800	11,950	7,200
Colorado	3,500	4,300	3,850	2,750
TOTAL RK. MT. ST.	48,100	46,500	49,000	41,000
New Mexico	49,300	47,250	48,050	41,550
California	492,600	465,700	506,600	427,900
TOTAL U. S.	2,520,300	2,473,850	2,542,100	2,183,300









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for February, 1935

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	332	326	112	155	3600	2	40	Rotary
Duval County	26	22	3	2	2300	2	22	Rotary
Archer County	62	45	16	44	660–1800	1 or 2	40	Rot.-Cab.
Conroe	2	2	0	2	2000–7400	3 or 4	40	Rotary
Refugio County	7	6	0	4	5200	2	38	Rotary
Oklahoma								
Oklahoma City	2	1	13	22	6500	3	39	Rotary
Pontotoc County	15	12	12	60	1800–4488	2 or 3	38	Rotary
Osage County	27	18	23	49	380–2850	2	37.5–40	Rot.-Cab.
Kansas								
McPherson County	12	6	2	26	2900–4300	2	38	Rot.-Cab.
Harvey County	3	3	0	9	3450	2 or 4	37	Rot.-Cab.
Ellsworth Arch	54	47	35	115	3300	4	37	Rot.-Cab
California								
Kettleman Hills	2	1	1	27	8300	3 or 4	40	Rotary
Long Beach	9	9	6	28	7000	3	36	Rotary

Field Activities by States for February, 1935

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1934 (In Barrels)
	February	January	February	January	February	January	February	January	February	January	
Arkansas	17	20	7	11	15	22	14	10	43	53	11,412,100
California	46	47	41	45	68	45	56	65	223	212	175,678,362
Colorado	1	1	1	1	....	....	3	4	30	24	1,168,000
Illinois	1	1	1	1	....	....	11	14	9	8	4,466,000
Indiana	25	6	21	4	....	....	1	2	49	54	813,000
Kansas	103	86	77	63	113	129	55	44	215	233	45,577,050
Kentucky	4	13	3	9	....	....	4	1	23	19	4,863,000
Louisiana	43	60	28	33	63	59	62	50	149	134	32,572,900
Michigan	27	28	19	21	26	48	130	132	131	149	10,589,600
Mississippi	3	3	1	0	....	....	1	1	13	11	Gas Prod.
Montana	3	8	2	4	....	....	7	9	39	44	3,797,000
New Mexico	18	15	16	10	....	....	17	14	86	88	16,529,050
New York	....	....	....	....	....	....	1	1	0	2	2,880,700
Ohio	121	117	91	83	....	....	42	52	174	214	4,291,000
Oklahoma	172	139	104	92	150	180	92	93	444	494	176,506,550
Pennsylvania	4	17	4	14	....	....	18	16	71	86	15,353,850
Texas	794	768	610	561	903	954	369	407	1011	1019	380,848,000
West Virginia	62	30	53	24	....	....	14	18	73	80	4,043,550
Wyoming	0	1	0	1	....	....	7	8	68	68	12,371,100
Total	1444	1362	1079	978	1338	1437	904	928	2851	3002	903,850,812

PROGRESS OF MAJOR PIPE LINE WORK

THE Lone Star Gas Company will construct a pipe line from the Long Lake field of Anderson County, Texas, to Dallas, it has been definitely announced by officials of the company. The line will be approximately 110 miles in length and, according to existing plans, it will be of 20-in. pipe. The date when construction work will start, and other details of the project, have not been determined upon.

●

The General Petroleum Corporation of California will construct an 88-mile pipe line from Taft, California, to its refinery and tank farm at Los Angeles Harbor, it has been announced. The latter part of February officials of the company asked for bids on 9250 tons of steel pipe. The line would be a combination 8- and 10-in. one, and will supplement the General Petroleum's existing pipe line facilities from the valley, an 8-in. line. Complete details of the proposed line are expected to be announced shortly by company officials.

●

Approximately 50 miles of crude gathering lines, operated by the Humble Pipe Line Company in north Archer County, southwest Wichita County, and eastern Wilbarger County, in Texas, have been purchased by the Gulf Pipe Line Company for an announced consideration of $25,000. The Gulf also received crude oil connections amounting to approximately 900 bbl. daily. The system consists of 2-, 3-, and 4-in. pipe, but the purchase did not include the Humble Pipe Line Company's trunk line in the district.

●

The Standish Pipe Line Company, subsidiary of the Phillips Petroleum Company, Bartlesville, Oklahoma, has purchased, and on March 1 took over, the Central Kansas Pipe Line Company. The Central's system consisted of approximately 142 miles of trunk and gathering lines in McPherson, Reno, Rice, Ellsworth, Barton, and Harvey counties in Kansas. The Standish and Central systems have been connected by the construction of 11 miles of line from the Ritz field to a point near McPherson, Kansas. The western terminus of the Central line is in the Breford Pool, Ellsworth County, extending to the refinery of the Globe Oil and Refining Company at McPherson.

The Central Kansas Pipe Line Company was organized at Wichita, Kansas, the latter part of 1932. Principal stockholders are the Darby Petroleum Corporation, Tulsa, Oklahoma; Slick, Pryor and Lockhart, Inc., Wichita; Ainsworth Brothers, Wichita; and C. L. Brown, Abilene, Kansas.

●

The White Eagle Oil Corporation has completed a 6½-mile, 4-in., screwed line, laid from the Robbins pool, south of Wichita, Kansas, in Sedgwick County, to the company's main line in the Eastborough pool. The company's refinery at Augusta, Kansas, is the destination of the oil. The new line increases the outlet for the Robbins pool. An electrically-powered pumping station has been constructed.

●

The Sinclair Prairie Pipe Line Company has laid a gathering system north from the Raymond Pool in Rice County, Kansas, the previous terminus of its 8-in. line. This extension of the Sinclair Prairie facilities gives an additional outlet to wells in the Grove, Byers, McFarland, Ploog, Orth, as well as other, pools in Ellsworth and Rice counties.

The Dickey Refining Company, McPherson, Kansas, will lay a 14-mile gas line from the Chindberg field, McPherson County, to the city limits of Lindsborg, Kansas, it has been announced. Gas will be supplied to the new municipal system.

●

The Gulf Pipe Line Company of Oklahoma has laid a temporary 3-in. line connecting its Cushing to Tonkawa line to the Marathon Oil Company's No. 1 Gilbert, a wildcat discovery well seven and a half miles east of Otoe, Oklahoma, in eastern Noble County. The well was shut in late in January after all available tankage had been filled.

●

The Cimarron Valley Pipe Line Company of Enid, Oklahoma, plans to lay a gasoline pipe line from Oklahoma into Nebraska. The line will extend from Enid across Kansas via Hutchinson, terminating at Superior, Nebraska. The Kansas State Corporation Commission already has granted the company a certificate of convenience and necessity permitting it to cross the state with the pipe line.

H. H. Champlin is president of the Cimarron Pipe Line Company, which is an associate company of the Champlin Refining Company.

●

A contract for the construction of 20 miles of 4-in. line to parallel a portion of its existing 4-in. line between Muskogee and Okmulgee, Oklahoma, has been let by the Great Lakes Pipe Line Company. The looped line is for the purpose of increasing the rate of flow between the two points, thus reducing the volume of gasoline the Muskogee shipper, the Pure Oil Company, is now compelled to keep in transit.

●

Construction of a pipe line from the Sam Fordyce field in Texas, to the new seaport at Brownsville, Texas, has been proposed by an oil concern operating in the area. The company, identity of which was not disclosed by the port commission, has agreed to construct a line from the field if given exclusive bunkering rights for fuel oil for 25 years.

●

A Rannett-type booster station will be installed by the Great Lakes Pipe Line Company on its line between Ponca City and Barnsdall, Oklahoma, it has been announced by officials of the company. The unit will consist of a 400-hp. motor driving a centrifugal pump. It is being added to increase the flexibility of the line, it is stated.

●

According to Finance et Industrie the project to supply Bucharest with "oilwell" gas from the Ploesti region, is about to be realized, says Consul General Harold D. Clum, Bucharest, Rumania. Engineer Caranfil, general manager of the Bucharest municipal plant, has succeeded in obtaining the co-operation of the large oil concerns, it is stated.

The preliminary contract between the Bucharest Municipality, which is reserving for itself the distribution of gas within the city and the companies that will transport the gas, already has been drafted. The pipe line to Bucharest will be constructed by the companies supplying the gas, while the distribution system will be installed by the Gas and Electricity Company (a private concern, having at present the monopoly of gas, electricity and water supply in Bucharest).

The work on the projected gas pipe line is expected to commence in the spring of 1935.

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 77.0 per cent **Central Division, 65.9 per cent** **Western Division, 47.9 per cent**

THE Cut Bank Refinery, operated by the Tarrant interests on the Blackfoot Indian Reservation in northern Montana, has been moved to Cut Bank, Montana. It is now located just south of the Roosevelt Highway in the east end of the town. Kenneth Davis is plant manager.

●

J. H. McLeod, Calgary, Alberta, Canada, president of the Royalite Oil Company and western production manager of Imperial Oil, Ltd., has announced that the Royalite company plans to construct and operate a second gasoline absorption plant in the Turner Valley field. The plant likely will be situated on the old Sterling-Pacific lease, a mile south of Gas and Oil Products, Ltd.'s absorption plant on the Mercury lease. No statement was made as to when construction work would start.

The Royalite Oil Company erected its first absorption plant in the Turner Valley field in May of 1933, enlarging it later in the same year. The plant has a daily capacity of 115,000,000 cu. ft. of gas.

●

The British American Refinery at Coutts, Alberta, Canada, recently increased its runs. The plant was operating three days a week and resumed its former schedule of 40 hours per week. Officials announce that the refinery will be completely overhauled in the spring and improvements made to equipment.

●

The McClanahan Oil Refining Company has started operating its new 1500-bbl. plant at St. Louis, Michigan. A mile of 3-in. line was laid to connect the plant with the pipe line carrier transporting crude from the Porter Pool to the Midwest refinery in St. Louis. Walter L. McClanahan is president of the McClanahan Oil Refining Company.

A unit is being remodelled at the plant of the United Refining Company, Warren, Pennsylvania, to adapt it for Dubbs full-flashing operation. Officials of the United recently signed a license contract with the Universal Oil Products Company, Chicago, Illinois, who control the Dubbs process. A flash chamber, bubble tower, and hot oil pump are being added, which will make possible the cracking of gas oil as well as reforming. The unit will have a cracking capacity of approximately 400 bbl. a day. The United's refinery at Warren has a daily crude capacity of 3000 bbl. and operates entirely on Pennsylvania crude.

●

The Arro Oil and Refining Company of Lewistown, Montana, recently installed a modern tetraethyl blending plant. The company is now marketing gasoline under the trade name of "Arro Hi Octane."

●

The Altitude Petroleum Corporation's refinery at Chanute, Kansas, shortly will be offered for sale to the highest bidder, officials of the company have decided. The plant, a 5000-bbl. refinery, has been idle for nearly a year. The equipment was modernized not long ago, and includes cracking units.

●

The Eason Oil Company is installing two 230-hp. Clark compressor units in its gasoline plant at Crescent, Oklahoma, to augment a battery of five of the same type units already in use. The units were purchased from Clark Bros. Company, Olean, New York.

●

The new 350-bbl. skimming plant of the Bay Refining Company near Bay City, Michigan, has been completed and put into operation. Crude is being obtained from Ogemaw County wells. B. W. Roke, engineer, had charge of the construction of the plant, which started operations with a storage capacity of 1000 barrels.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending March 2, 1935

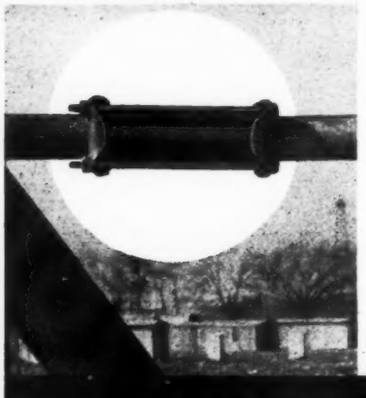
A. P. I. Figures
(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	467,000	80.2	16,969	10,043
Appalachian	93.3	97,000	69.3	2,155	929
Ind., Ill., Ky.	94.6	344,000	81.5	9,830	4,146
Okla., Kans., Mo.	83.7	237,000	61.4	5,489	3,849
Inland Texas	47.6	96,000	57.5	1,423	1,844
Texas Gulf	97.7	514,000	87.6	6,711	8,960
La. Gulf	96.4	107,000	66.0	1,446	3,828
No. Louisiana-Ark.	83.7	44,000	57.1	260	421
Rocky Mountain	66.7	29,000	45.3	911	724
California	96.9	416,000	50.6	10,460	65,596
TOTALS WEEK:					
March 2, 1935	89.8	2,351,000	69.0	55,654	100,340
February 23, 1935	89.8	2,432,000	71.3	54,399	100,579

ABOVE—*Showing how producing wells are being hooked up with Dresser Sleeves*

Many of the oil wells in Fitts Pool are fitted out with Dresser Sleeves & Dresser Couplings

BELOW—*Dresser Sleeve makes a convenient, tight connection on oil-well piping*



make *Quick Connections* in Oklahoma's Newest Pool!

HERE, as in other active oil fields, most operators are using Dresser joints to speed the completion of all piping at the wells. Why?

FIRST, because time is too valuable to permit fussing and fumbling with old-fashioned, hard-to-make connections. It's so much simpler and quicker to use plain-end pipe and Dressers. Absolute tightness is a certainty!

SECOND, Dresser flexibility takes care of all expansion, contraction, and vibration to which exposed lines are subjected.

THIRD, whenever it is necessary to dismantle piping — as in the case of Christmas trees — Dresser joints are easily disconnected (and reconnected) with a ratchet wrench.

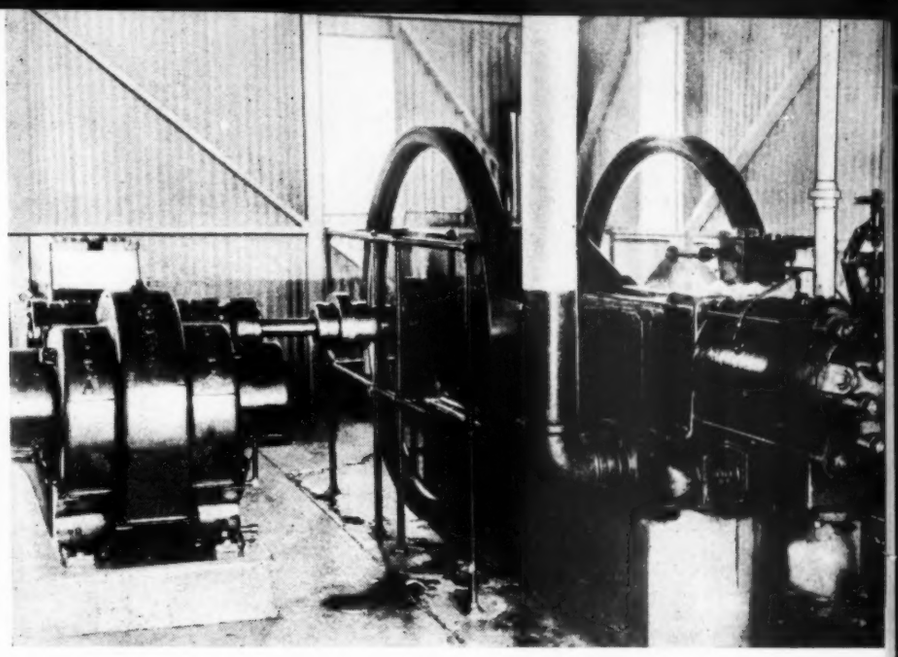
Check These Popular Uses of Dresser Connections!

1—Christmas-tree hook-ups at the wells.
2—Flow lines running from Christmas trees to separators, and from separators to field storage batteries.
3—Exhaust lines from Diesel drilling engines.
4—Flow lines on top of tank batteries.
5—Bleeder lines from tank batteries.
6—Flow lines from gathering stations to tank storage.
7—Main lines from gathering stations to loading terminals.
8—Flowing plant lines.
9—Natural gasoline plant lines.
10—Refinery lines.
11—Natural gas gathering lines.
12—Natural gas booster stations.

Dresser Factory-Made Joints are as Near to You as Your Nearest Supply Store!

S. R. DRESSER MFG. COMPANY, BRADFORD, PA.

In Canada: Dresser Mfg. Co., Ltd., 32 Front St., W., Toronto, Ontario



A 40-hp. valveless Diesel-type engine direct-connected through flexible couplings to a 5-7 by 10 reciprocating pump. This unit is capable of pumping 150 to 160 bbl. of crude per hour

Pipe Line Practices and Problems in Western Kansas

By FRANK H. LOVE

NUMEROUS pools, widely scattered, the level nature of the country, which makes construction of gravity gathering lines virtually impossible, and hydrogen sulphide content of crude in certain areas are among the factors giving rise to problems that confront pipe line operators in western Kansas. Some of the pools in the area are comprised of but one or two wells and the distance it is necessary to lay a line to provide an outlet, together with the cost of constructing a booster station, often creates an expense incommensurate with the small volume of production obtainable at the time. However, provision of pipe line connections frequently stimulates drilling activity and results in the development of an oilfield considerably greater than otherwise would have been likely and eventually results in the pipe line company realizing on its investment.

In order that the cost of moving the crude be not excessive, the general practice is to use light equipment, easily and inexpensively installed, and readily movable to a new location when depleted production makes it advisable. Quite frequently when an area is developed into a sizable producing field it becomes necessary to replace this light, temporary equipment with larger pumping units, and western Kansas has some exceptionally fine pumping stations, both field boosters and main line.

Kansas possibly has a greater number of field booster stations, in comparison with its volume of production, than any other Mid-Continent area. This is due to the flatness of the country, which enables construction of gravity field gathering systems only in rare instances. In certain eastern sections of the state the topography is sufficiently rolling that the crude can be run by gravity to a main line pumping station, but in western Kansas this practice is seldom possible.

The predominant type of equipment for field boosters consists of gas engines driving reciprocating pumps, and electric motors powering the same type pump. These vary to include engines using natural gas and kerosene as fuel, and certain of the larger field stations are powered by small Diesels. As to size of the equipment, one pipe line company, where each field station takes production from but one or two wells, is employing a 30-hp. motor driving a reciprocating pump with a 3-in. bore and 10-in. stroke. This unit operates on a line pressure of 50 lb. and is capable of pumping 130 bbl. of crude an hour. The operating economy of this unit is a worthwhile factor, one gauger being able to look after eight to ten such pumping set-ups. An interesting feature is the manner in which the motors are mounted to assure a constant belt tension. Since one gauger is required to oversee a number of the field stations and, therefore, cannot give each his constant attention, it is desirable that some means be employed to assure the proper belt tension, thus guarding against drive trouble such as slippage with its resulting reduction in power-transmitting capacity, or too much belt tension, causing excessive wear on the belt and bearings. To accomplish this the motor is mounted on adjustable arms, extending from a free-swinging pivot shaft. The weight of the motor is thus lightly cradled in the belt, constantly maintaining the required belt tension. The correct belt tension is determined by simple adjustment when the drive is installed and, once established, is automatically maintained. The driven load determines the tension required, and the location of the motor on the adjustable arms governs the tension. The farther the motor is removed from the pivot shaft the greater is the belt tension, and, likewise, bringing the motor closer to the pivot shaft reduces the belt tension. Whenever changes in belt length occur, due to atmospheric conditions, peak loads, centrifugal force, or normal stretch, the motor instantly and automatically adjusts its pivoted position and maintains the belt at constant tension.

These field boosters are situated within a few hundred feet of, and slightly lower than, the tank batteries, the crude gravitating to the pumps and then being boosted to the main line.

One major company operating in western Kansas encountered a condition that recently made it necessary to loop its

A neat appearing and efficient field station in Ellsworth County, Kansas. This station has a capacity of approximately 60 bbl. per hour

lines on certain portions of the system. Since many pools have but few producing wells, it is no uncommon occurrence for a line to be laid five or six miles to connect a wildcat well. When this is done it also is necessary to construct a booster station. This situation recurred until, on certain portions of the system, so many field stations were pumping into the main gathering line that line pressure was increased to a point where the pumping volume of the main gathering stations had to be reduced. To remedy this the company paralleled its line from the Brandenstein field station in Rice County to the Smoky Hill River junction, a distance of 37.8 miles. By so doing the line pressure was reduced, the field stations were enabled to pump into the line without the station at Gorham having to be held in check, and has enabled that station to operate at increased capacity.

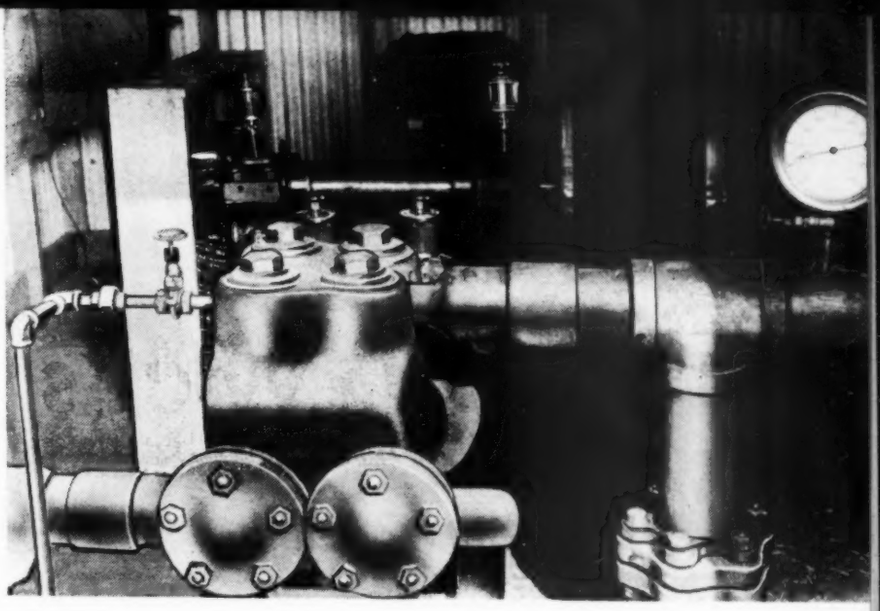
The company, taking oil from 22 fields in western Kansas, is the principal transporter of crude from the area and has an excellent system of field booster and main line stations. Gas engines and electric motors are the principal powers used in the small field boosters. These are usually 30- and 40-hp. units and drive reciprocating pumps. The main gathering stations, of course, have heavier equipment consisting of 75- to 90-hp. Diesels powering reciprocating pumps; and the power units in the main line stations are principally Diesels of up to 260 hp., with some large electric motors also used. Two main line stations, recently completed, at Haven in Reno County, and Hudson in Stafford County, include features that are of particular interest. Engine and pump rooms are separated by a firewall and at one end of the building are situated the auxiliary equipment, office and change room, walled off from the engine and pump rooms. The building's exterior is of face brick, the interior of face brick finished with salt-glazed tile. The roof is of steel frame, covered with corrugated transite asbestos sheets. Small units of ventilating steel sash and a small swinging door are installed in removable steel frames, to provide large openings for moving equipment in or out of the building. This type of installation is entirely weather-proof and reduces to a minimum the troubles experienced from fine sand and dust. Incidentally, as a further means of preventing dust and sand damage to machinery, all stations in the area are provided with air filters. An additional feature of the Hudson and Haven stations is the arrangement of the firewall and partitions, and the placing of the doors, accomplished in such a manner that it is impossible to create a direct passage for the movement of air from one side of the building to the other, a precaution against fumes or fire passing from the pump to the engine room.

Considerable trouble has been experienced in western Kansas in the operation of Diesel engines, particularly of the high-speed type, due to the corrosive action of hydrogen sulphide gases present in some of the fuel oil seriously affecting the efficiency of the high-pressure injection systems used on this type of engine. As yet no suitable materials have been found that will resist this corrosion and give satisfactory operation, although attempts have been made to construct parts of certain alloys. The hauling of "sweet" oil for fuel has been practiced in certain instances, and in others pipe of small diameter has been run to conveniently located leases producing suitable oil.

Crude containing the highest hydrogen sulphide content is that produced from the Siliceous lime, and the areas where the condition is most troublesome are Russell County and the Voshell pool in McPherson County.

This problem of "sour" crude has resulted in a widespread use of wooden tanks in field batteries from which the booster stations pump. The tanks embrace special construction features that are of interest. They are made of California redwood, which is unaffected by hydrogen sulphide and is noncorrosive. The deck is of 2-in. redwood that fits snugly into grooves approximately six in. beneath the top of the staves. In like manner a 2-in. bottom fits into similar grooves near the bottom of the staves. The planks of both head and bottom are strengthened by heavy transverse timbers on their top-side

Hydrogen sulphide content of crude in certain areas of western Kansas has resulted in the widespread use of wooden stock tanks

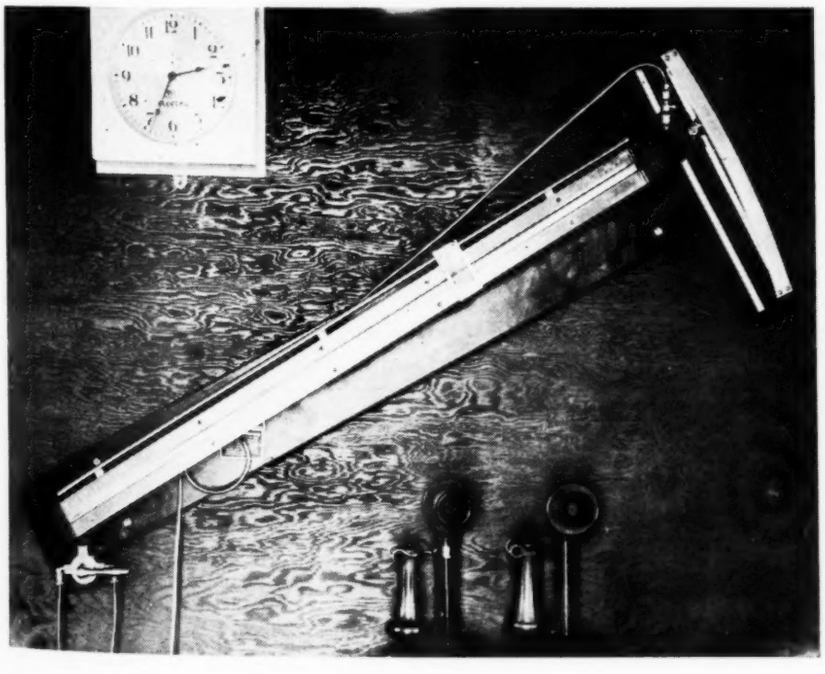


A small field booster unit. The motor is mounted on a special base in such a manner that the required belt tension is automatically maintained

and similar matching timbers on their bottom-side, the timbers being securely fastened together through the heads, making a double-headed, tight tank. A number of ¾-in. steel tie rods extend vertically from the timbers beneath the bottom through the timbers on top, creating a tank capable of withstanding high internal pressure. The head of the tank is kept covered with six inches of water. The edge of each stave has a small groove milled down its midwidth from the top to a point immediately above the tank bottom. Small lateral holes above the deck permit the water on top to fill these stave grooves, from where it permeates the staves and keeps them properly tight. The water also serves as a cooling medium for the oil during the summer months.

Since western Kansas is subject to a winter temperature at times as low as 25 degrees below zero there are seasons when paraffin deposits in gathering lines and tank bottoms create a somewhat troublesome condition. It is rarely that a scraper has to be run on any except 4-in. lines, or smaller. On these it is sometimes necessary for the scraper to be run every thirty days. One common method of removing paraffin from tank bottoms is by use of a steam line. The usual practice is the introduction of a line into the tank through the manhole plate, the line being a 2-in. one from the boiler to the manhole and 1-in. inside the tank. To the end of the line is attached a 2-way or 4-way tee and nipple, which are lowered into the tank. Steam, supplied by an oilfield boiler, is injected into the tank and the crude agitated the required length of time.

In a number of western Kansas pipe line stations an automatic gauge, called a Pneumercator, has been installed. These instruments, while not new, have within recent months come into more widespread use in connection with pipe line work in the area. They make possible gauging from the station office of fuel tanks, working tanks, water tanks, or, for that matter, any tank containing fluid. A saving of time is involved, the necessity for an operator leaving his post for any great length of time is eliminated, and a certain safety feature is embraced. The principal elements of the gauge are an indicator, a balance chamber, and a control valve. The indicating device is an inclined column of mercury. The balance chamber consists of a hollow bell-shaped casting, near the base of which is an orifice and at the top an opening connnecting by means of ⅜-in. tubing with the indicating gauge. The balance chamber is submerged in the liquid to such a depth that the center of the orifice is at the level from which measurement is to begin, designated as the zero level. In the case of oil this is at the B.S. level, frequently 11⅞ in. above bottom. The balance chamber is secured to the side of the tank. Since it is often necessary to gauge liquids of varying specific gravity the indicating column is pivoted so that it can be moved through a small arc, and is fitted with a pointer that registers with a scale graduated in specific gravity. To gauge a tank the operator sets the pointer at the observed gravity. Compressed air is admitted through the ⅜-in. tubing to expell all liquid from the balance chamber. This is accomplished by means of a control valve attached to the gauge. The air pressure in excess of the liquid head escapes through the orifice in the balance balance chamber to atmosphere, the liquid in the balance chamber thus being placed at the zero level, and a proper balance established between the liquid head in the tank and the mercury in the gauge indicator. A correct reading of the volume of fluid thus results. Where there are a number of tanks to be gauged it is not necessary that each tank have a separate gauge; one instrument may be connected to several tanks through a manifold.



Many western Kansas pipe line stations are equipped with automatic gauges. Here is shown the indicator of such a gauge

Locating Water Entry in Flowing Wells

Electrical Method by Which Source of Water in High-Pressure Wells is Determined Without Interrupting Production

By

WALLACE A. SAWDON

Petroleum Engineer, Los Angeles

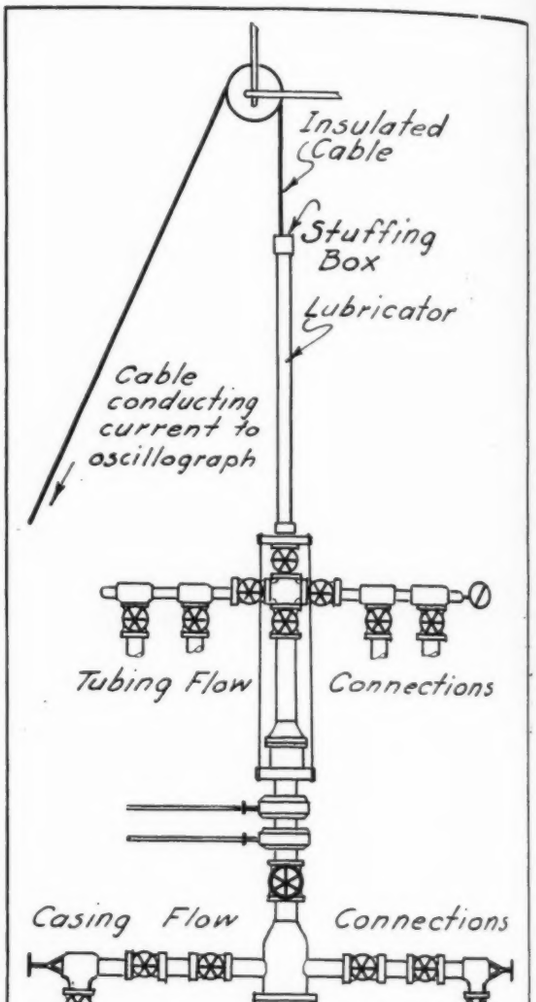


Fig. 1. Here is shown the instrument in the well with the cable running through a stuffing box. The lubricator is made up above the flow connections that are on the well

THE location of water entry in flowing wells has often presented a problem difficult of solution. Yet an accurate knowledge of just where water enters may be a means not only of eliminating the production of cut oil but also of protecting producing zones and thereby insuring a higher ultimate yield. The location of water-bearing strata will, moreover, be valuable in development work; but since the source cannot always be determined during drilling, a knowledge of the point of entry can often be obtained only after a well has been put on production. In most cases, however, it is undesirable to interfere with the flow of the well until the source of the water is known and plans made for taking care of it. The use of a method for determination of water sources in flowing wells without disturbing producing conditions will, therefore, be found valuable in providing data that can be used both for repair work and as a guide in the completion of surrounding wells.

An electrical method for locating water entry in a flowing well has recently been developed and has been successfully used to determine water sources of wells producing in various fields. The pressure of the well can be high or low as long as the well is flowing. In making the study by this method, the normal rate of flow of the well is maintained and all subsurface conditions kept the same as during production. Instead of killing the well and conditioning it for the study, it is often desirable when wells are pinched in to open up the flow to get free movement from all the formations.

This method is called the "Droplet Counter" and is being operated by the Oilfields Service Company of Long Beach. Its principal function is to indicate the frequency of impinging droplets of water in a flowing column of oil, gas, and water as they pass through a detector as it traverses the well. In addition to the frequency measurement, however, a "dielectric" or mass resistance of the fluid is also recorded and the variation of this dielectric value shows the changes in concentration of the fluid mixture. The dielectric not only serves to check the frequency reading, but also adds data that assist in a close interpretation of the study. Since the measurements made record the effect of moving droplets of water in an oil or gas column, the flow must be maintained at a rate that will insure the water droplets do not have an opportunity to migrate downward from the source. The movement must, therefore, be maintained upward.

The entire recording operation is automatic. The detector, which picks up both frequency and dielectric values, is run into the well on the end of an insulated cable containing conductors that carry the electrical measurements to the surface. Here the currents pass through a control box and are recorded by means of an oscillograph. The frequency impingement of droplets of water causes one oscillograph

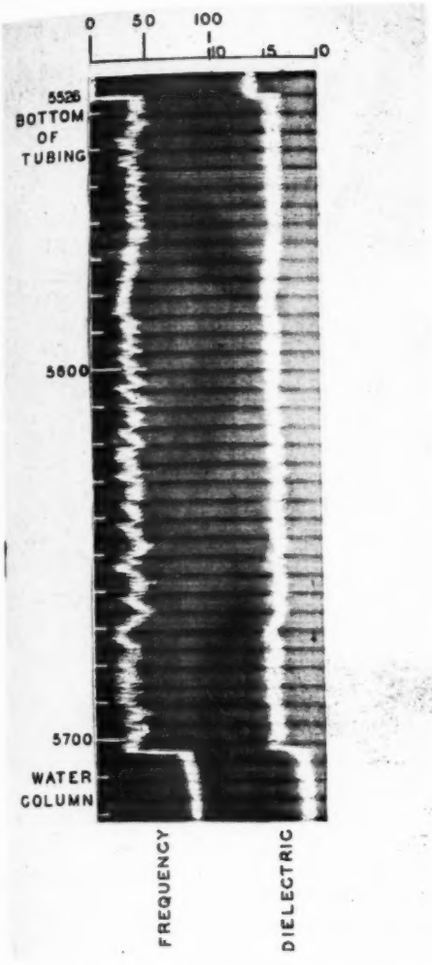


Fig. 2. This record disclosed the point of entry of bottom water

wire to oscillate and the changes in concentration of the fluid cause variations in a second wire to register the different dielectric values. The oscillations of both wires are photographed on sensitized paper in a camera that rotates the film in synchronization with the travel of the detector in the well. The depth indications are thus recorded at the same time and automatically tie on the frequency and dielectric readings with the exact depth at which they occur.

The Droplet Counter detector can be adjusted to obtain the lower limit of diameter of droplets that register. It is lowered to the bottom of the hole, the switches are turned on, the gears thrown in and an upward traverse made of the depth interval where water entry may occur. After the complete traverse has been made, the mechanism is stopped and the film developed immediately right on the job. Check runs can be made without removing the instrument from the hole.

In preparing for a "Droplet Counter" study, only the following procedure is necessary:

1. A part of the flow is directed through the casing and is maintained at a rate that is as high as is practical for the well.
2. The tubing is hung with its bottom above the perforations of the liner or above the source of any production in open hole. This tubing must have a minimum inside diameter of 1¾ inches to allow for the passage of the instrument.
3. A mud pump is connected to one flow line from the tubing.
4. A lubricator, made of a joint of tubing, is placed on top of the christmas tree to provide insertion and removal of the instrument when pressure may make its use necessary. The top of this is equipped with a stuffing box through which the insulated cable runs.
5. Clean oil is pumped into the tubing to reduce pressure to a prescribed amount. (See Fig. 1).

With the flow coming from the casing and the tubing full of oil under a reduced pressure, the detector is inserted and run to bottom. The depth is indicated by an odometer on the cable at the hoist used for running the instrument in and out of the well.

Electric current for the detector and for operation of surface instruments and apparatus is supplied by a motor-generator set driven by the motor of the truck on which the hoist is mounted. The oscillograph, camera, and photographic developing outfit are in a trailer. The entire study of a well for water entry is thus made at the location; the results and interpretation are made immediately after a run of the Droplet Counter has been completed.

The Record

The photographic record of both the frequency and dielectric is furnishd in a continuous strip like ordinary 35-mm. moving picture film. On the extreme left are white horizontal lines that indicate 10-ft. intervals of depth. These are correlated with the depth read at the hoist and by being photographed simultaneously with the oscillograph readings provide a completely automatic record.

In Fig. 2 is given a reproduction of a study record of a well where the water entry was found to be at the bottom of the hole. The wavy line on the left half is the frequency curve, which is a measurement of the droplets of water impinging against the detector. The extreme left of the film is a point of zero frequency; that is, when no water exists in the fluid, a straight line runs down the left-hand edge of the film. Such a condition exists in the record shown until the bottom of the tubing is reached. At the point (5526 ft.) where the detector passes out of the clean oil in the tubing into the cut oil flowing up the hole into the annular space between the tubing and casing, the frequency curve breaks over to the right.

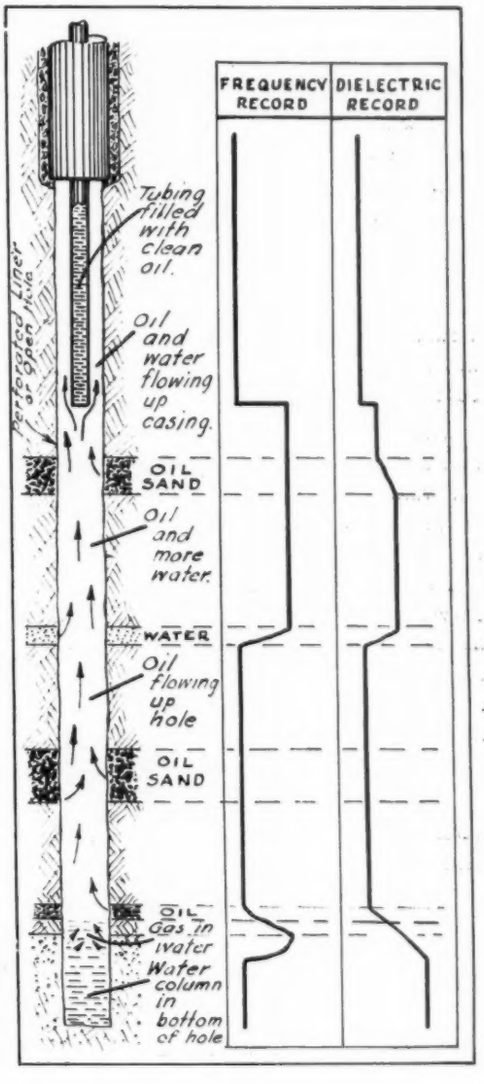
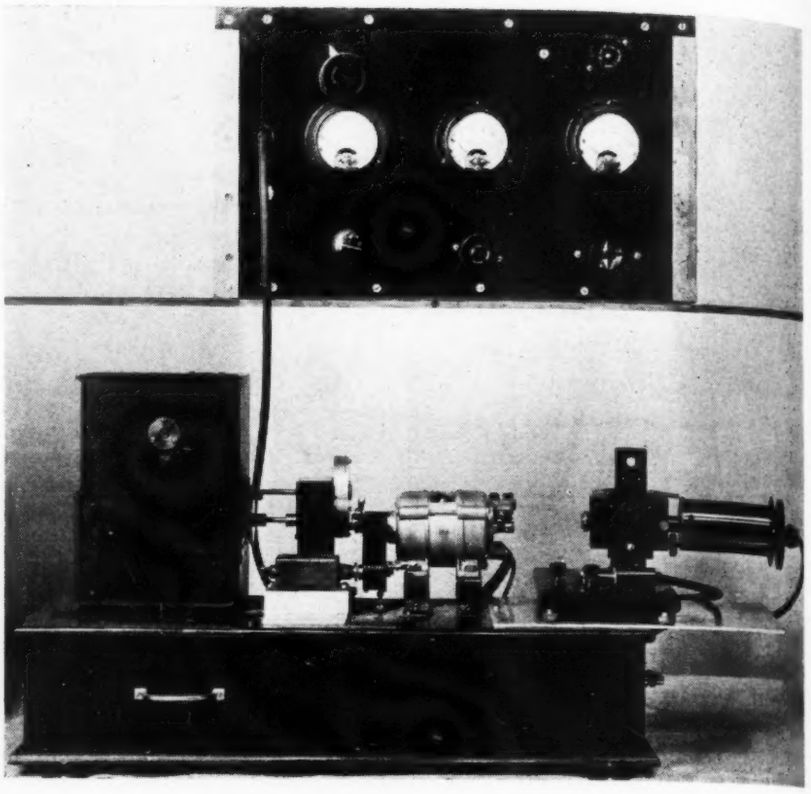


Fig. 3. The frequency and dielectric curves are here shown plotted opposite the conditions discovered in the well



The currents pass through the control box and are recorded by means of the oscillograph. To the left, bottom, can be seen the camera, which records the frequency and dielectric curves automatically on a moving film

The frequency line then continues as a wavy line to a point (5703 ft.) where it takes another sharp break to the right. Above this point, the fluid consists of oil and water; below it, the frequency curve is a solid line that indicates a column of water.

The curve on the right-hand half of the film records the variation in dielectric values. Its limits of travel are from the extreme right edge to the middle of the film. It lies toward the middle while the detector is passing down the tubing and thus indicates clean oil or a high resistance medium. At 5526 ft., where the instrument passes out of the tubing and into the flowing fluid, the dielectric curve breaks to the right, showing a decrease in value due to the presence of water.

The dielectric curve then continues in the same line to 5703 ft., where it makes another sharp break to the right. At this point the detector has entered a water column of low dielectric or minimum resistance.

It will be noted that both the frequency and dielectric curves break at the same points and provide a check for each other. If there had been a change in the percentage of water in the fluid flowing up the hole, this would have been indicated by a change in the position curve with a slight slope of the line showing increase or decrease in value. On the dielectric curve, a change in the percentage of water would be indicated by a very decided change in slope showing the points of depths at which the variation in water content occurred.

The interpretation of the curves obtained in this study indicates definitely that water enters at or below 5703 feet. The values show no movement of gas or oil below this point, so the zone below is unproductive. If the hole were plugged to 5703 ft., no productive formation would be lost.

To show the behavior of the frequency and dielectric curves where water entry is between two oil sands, Fig. 3 has been drawn to present the conditions graphically. Both curves are shown as straight lines since the scale is highly distorted, the vertical distances being considerably greater than the sketch would indicate.

As in the case cited above, both curves broke sharply to the right when the detector passed out of the clean oil in the tubing. The frequency curve then continued straight down until the water sand was struck since the rate of passage of water droplets through the instrument remained constant. The dielectric, however, sloped off to the right as it passed through the oil-producing sand because the percentage of water increased and the dielectric value decreased. From the bottom of the oil sand it continued straight down until the top of the water sand was encountered.

On passing downward through the water sand, both curves sloped to the left since the detector again entered clean oil after passing through the water that was evidently carried up the hole by the flow.

The bottom of the hole evidently was filled with a column of water that did not have an upward flow, for both the frequency and dielectric curves remained in a straight line until just before the water column was reached. At this point, a little gas agitated the water for a little distance and caused the frequency curve to slope to the right. Then, because actual flow of fluid caused no impinging of water droplets on the detector after the gas disturbance was passed, the frequency curve returned to zero.

The dielectric curve, however, sloped to the right with the decrease of resistance due to gas agitating the water until it reached the still water below where the resistance was minimum. From there the dielectric curve continued downward in a straight line. Although the description and interpretation as here given are presented from top to bottom, the instrument is run from bottom to top.

From the past studies made with this instrument, it has been proved that the lower limit of water entry is determined with considerable accuracy and that the definiteness of the location of the upper limit has provided satisfactory results. The repetition of measurements in the wells studied has provided adequate check readings and measurements at given levels have given duplicate values.

Besides the accuracy attained, this method is advantageous because it provides a means of locating water sources without disturbing producing conditions. Oil and gas do not interfere with the readings and the time required for making a study of a well is short. The elimination of the human element by making the operation automatic and causing the photographs to be taken during the run is also a desirable feature.

Diaphragm Type Control Valves

By W. C. BEGEEBING

DIAPHRAGM VALVES. The valve is important, it is the business end of the control system. Its flow characteristics, its materials and its size merit careful consideration. The sizing of the valve is no longer the critical matter it was in the early days of automatic control but gross overvalving will still defeat good control. Recognition of this is evidenced by the definite information now available of valve capacities, to obtain which valve manufacturers have spent literally hundreds of thousands of dollars. Typical data are in the form of nomograms but the chart, Fig. 1, which was devised by the writer, has several advantages over the nomogram. Quicker determinations are obtained and it actually pictures the capacities for all pressure drops. Thus visual comparison and inspection of pressure drops, capacities, and sizes make precise selection possible. All such valve capacity data are based on wide-open valves.

Before accurate valve capacity data were available, the most common error found in control installations was oversize valves. Unfortunately, this error is still made because of inexactness in stating the maximum allowable pressure drop when the job is being engineered. The pressure drop for each valve must be determined by the design engineer as closely as possible. With generous pressure-drop allowances for his piping and apparatus the result is often to have an actual available drop across the valve several times more than the design figure from which the valve was sized. This type of experience led one large oil company to adopt the following standard practice — one that is worthy of general adoption. Control valve bodies being invariably smaller than the line size are installed between reducing nipples, each of which is provided with a ¼-in. tapping and plug. Should poor operation suggest overvalving, the suspicion can be quickly confirmed by connecting an indicating pressure gauge to each nipple and by thus obtaining the upstream and downstream pressures, the actual available pressure drop is revealed and the valve can be replaced by one of the required size. This same company also installs a small tee with the branch plugged at the diaphragm chamber connection of all valves. A pressure record of the controlled air pressure to the valve can then be obtained and control characteristics may be intelligently studied if faulty operation develops. No better tell-tale of control operation characteristics can be employed.

The early form of diaphragm valve superstructure or top was a rather crude affair. The diaphragm chamber was mounted on the valve body by a spider and the saucer was held against the rubber diaphragm by a spring that rested on the stuffing box nut of the valve body. Very satisfactory refinement has been made and modern control valves (Fig. 2) have the spindle guided at two points by anti-friction bearings, which precisely center the stroke through the stuffing box and permit a smaller cross section of the spindle at that point. This, of course, makes for a minimum of stuffing box friction. A stuffing box lubricator is almost universally furnished. The spring or multiple springs of the superstructure rest against a cross member of the top, making spring adjustment independent of stuffing box adjustment. The

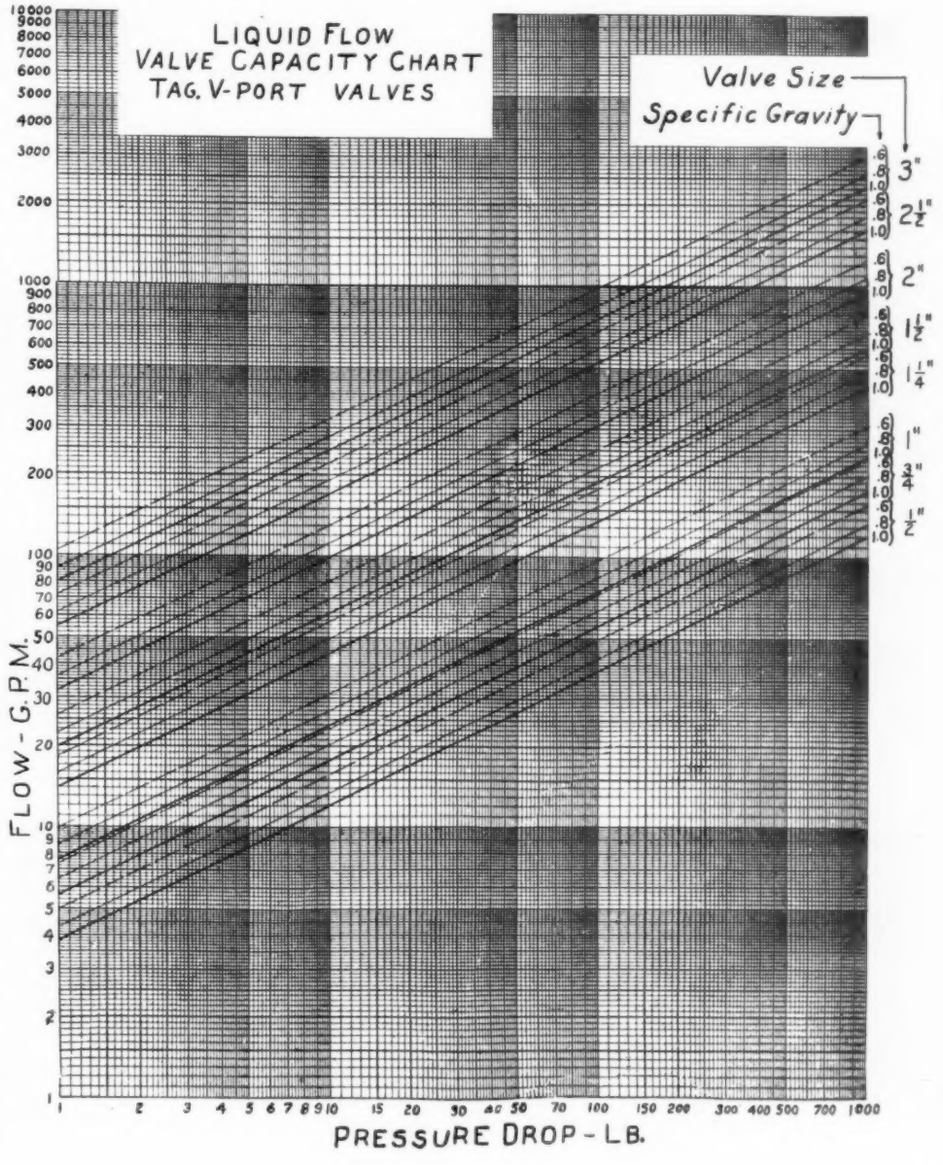


Fig. 1. Liquid flow valve capacity chart Tag. V-port valves

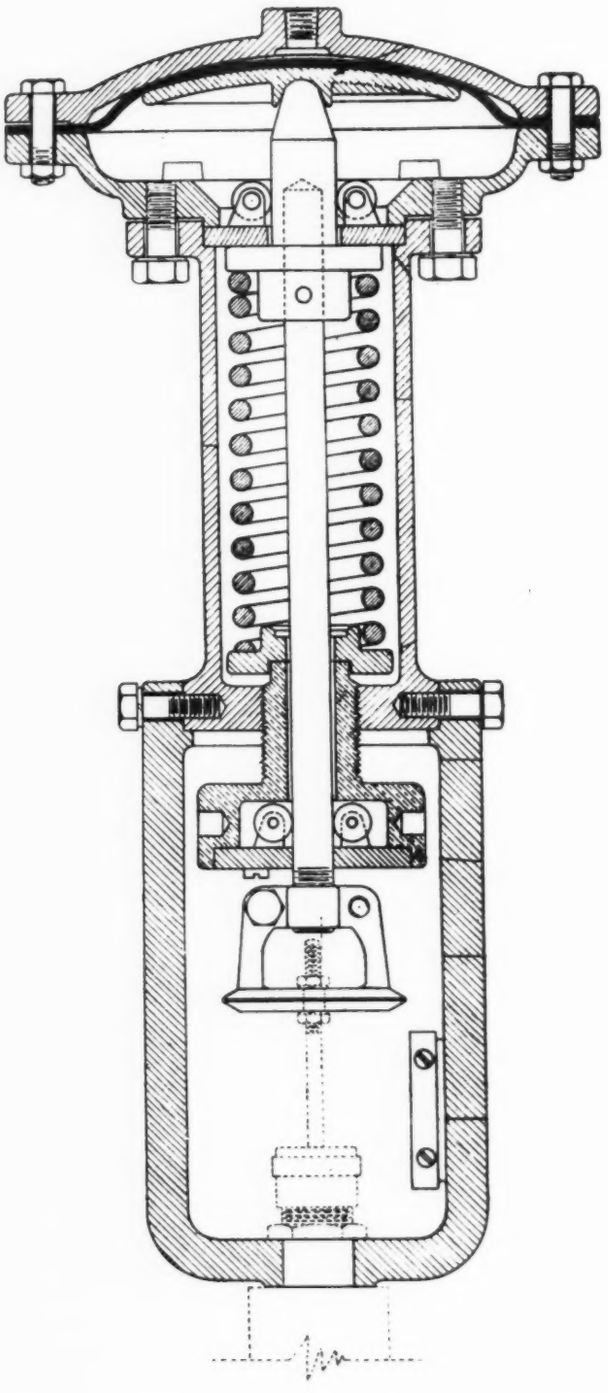


Fig. 2. Modern control valve with spindle guided at two points by anti-friction bearings

spring and bottom side of the diaphragm are enclosed and removable cover plates are provided that still allow the position indicator to be seen at all times, (see Fig. 3).

The sum of these refinements is a valve that will resume a definite position for any certain air pressure on its diaphragm regardless of whether the air pressure immediately previous was higher or lower; or, in other words, a valve whose flow characteristic curve from open to shut would be identical with the curve from shut to open. Discrepancy between these curves, of course, reflects stuffing box friction.

Extremely small capacities are not ideally handled by double-seated semi-balanced V-port or parabolic plug valves where indeed the small inherent leakage in the closed position might in extreme cases constitute a considerable percentage of the maximum desired flow. The single-seated needle type valve is better suited for these minute capacities and when properly designed may approach a veritable "needle" in size and yet not be cursed with a tendency to freeze shut. High lift and desirable flow characteristics are readily obtainable and exceedingly small quantities may be regulated. Obviously the needle valve cannot be supplied reverse-acting (spring-closed) by simply reversing the body, for this would require the spindle to pass through the orifice or seat ring and preclude true needle-valve design. To make a needle valve reverse-acting the simple reversing mechanism, shown in Fig. 4, produces an upward movement of the needle disk (opening the valve) when the upper spindle moves downward with increasing air pressure.

Longer stuffing boxes and air-cooled bonnet with radiating fins for high temperature fluids are generally available. For very low temperature fluids an open oil cup arranged above the stuffing box keeps a film of oil on the emergent portion of the valve spindle and inhibits its frosting.

The reversibility of a valve from spring-opened to spring-closed in the field is, of course, a very desirable feature. Practically all double-seated semi-balanced valves are basically reversible, but not in all can this reversal be accomplished without obtaining or making a new spindle and machining the inner valve assembly to receive it.

Though an instrument, certain air-reset controllers are more logically considered in this valve discussion than else-

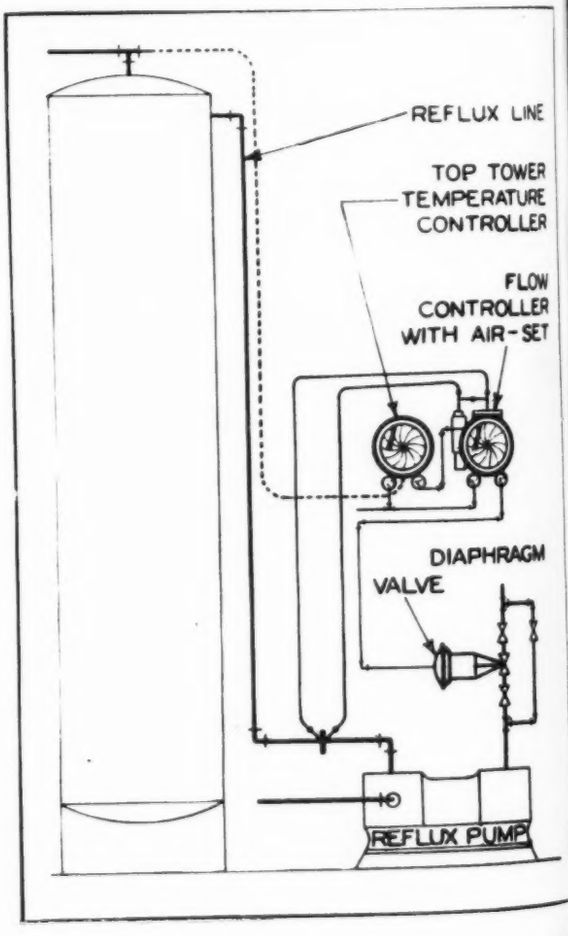


Fig. 5. Hook-up of flow controller with orifice plate installed in reflux line and operating steam valve

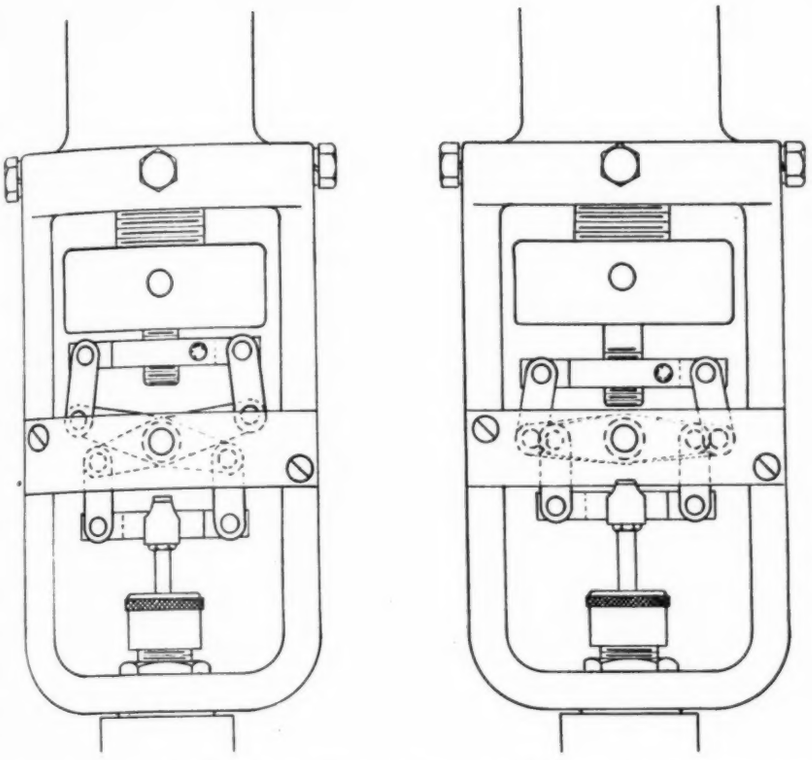


Fig. 4. Simple reversing mechanism to make a needle valve reverse-acting

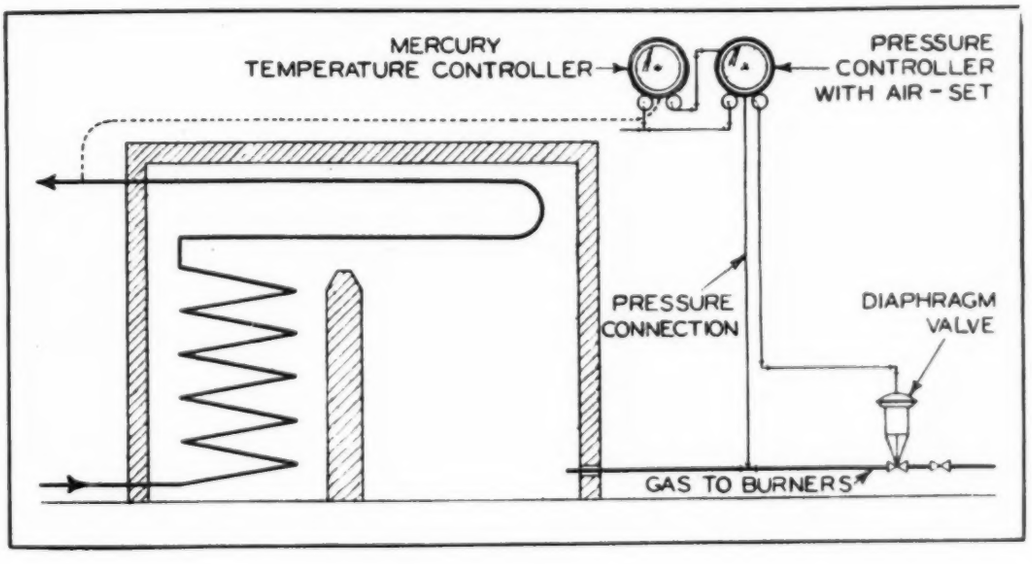
where. In an ideal control installation nothing should affect the flow of the controlled medium except departures from the controlled condition. Consider a top tower temperature controller operating a steam inlet valve to the reflux pump. The temperature is being exactly maintained because the controller is working the pump so as to reflux just the right amount. Elsewhere in the yard, steam demands change and the steam coming to the valve is now at a lower pressure, the pump slows down slightly, less reflux goes over, the temperature rises. True, the temperature controller now corrects the pump speed by opening the valve wider and presently we are again maintaining the correct temperature. But we allowed an external variable to affect our temperature. Now, let us install a flow controller with orifice plate in the reflux line and operating the same steam valve, (see Fig. 5). This flow controller will have an air motor in its case that can position the setting pointer across the entire scale as the air pressure in the air motor is changed by the original temperature controller connected to this air motor. The only thing that can now change the reflux rate is a change in temperature at the tower top. Changes in steam pressure or pump efficiency can no longer disturb the control. The secondary reset type controller intercepts and eliminates all external variables.

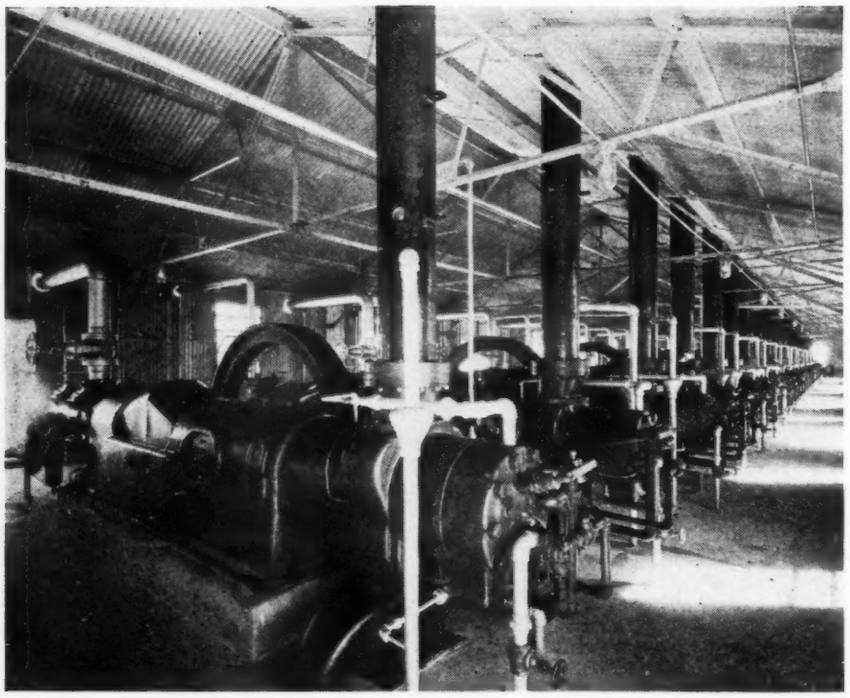
The additional cost of this installation naturally restricts its use to those installations where very nice results are demanded. However, the secondary controller can also furnish a useful record of reflux flow and since it can be manually reset as well as automatically it provides an emergency control should the temperature control be removed for repair. Level controllers resetting flow controllers and temperature controllers resetting pressure controllers are used for similar reasons, the latter hook-up finding favor on transfer line temperature control of gas-fired furnaces, (see Fig. 6).

Certain prime movers, such as steam turbines and uniflow engines, have inbuilt speed control devices that do not readily lend themselves to air operation, although diaphragm motor levers have been successfully used under favorable circumstances. Where diaphragm motor levers cannot be used, the electric motor has been successfully employed. Inasmuch as the speed control device itself usually depends on the rotation of a handwheel feeding a screw in and out, it is only necessary to substitute a driven gear for the handwheel and a driving gear on the shaft of a reversible motor. The motor is operated by a flow meter with electric contacts.

Fig. 3. Spring and bottom side of diaphragm enclosed, but position indicator visible at all times

Fig. 6. Hook-up showing temperature controller resetting pressure controller on transfer line temperature control of gas-fired furnace





Modern super-two-cycle engine compressor plant, with overhead water-jacketed exhausts

By

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Modern Developments in Oilfield Gas Engine Design*

DURING the decided lull in business, which has been an occasional topic of conversation during the past few years, several of the manufacturers of oilfield internal combustion engines have been in a position to do considerable research and design work with the object of improving their equipment in anticipation of a revival in demand. Most of the effort expended has been directed toward obtaining more horsepower per pound of metal; in other words, more power per dollar of cost. Different organizations have naturally pursued different methods of attaining this objective, but it is possible to classify these methods under three headings:

1. By development of lighter, higher speed designs.
2. By increase in piston speed of present designs.
3. By attainment of increased thermal and mechanical efficiency through improvement of existing designs.

Let us consider the various methods in the order mentioned above. Probably the most striking example of the adaptation of high-speed engines to oilfield work has been their increasing use in many sections of the country as oil well pumping units. Most of the engines of this type on the market at the present time have been developed from tractor and truck motors. While some manufacturers offer their standard automotive motors with no change other than the substitution of a natural-gas mixing valve for the liquid fuel carburetor, those builders who are attempting to sell on quality rather than on price have for this heavy continuous service incorporated improvements such as renewable valve seats, heavier supports, higher compression heads, heavier duty clutches, and larger capacity lubrication and cooling systems.

Engines of this type are now being used for auxiliary purposes in absorption plants and compressor stations. One engine of this type has now been in operation locally for over 30,000 hr. at 1050 r.p.m. and 51 lb. b.m.e.p., and is pronounced by the operating engineers to be satisfactory.

While the high-speed engines discussed above are excellent for oilwell-pumping purposes, the smaller sizes are somewhat limited in their ability to develop sufficient hp. for pulling tubing and for other well-servicing purposes. To meet the demand of the operator who asks for a unit that is suitable for servicing as well as for pumping, the familiar horizontal single-cylinder engine in greatly improved form is available. Several manufacturers now supply these engines in designs that can be operated on natural gas or Diesel oil. When operated on Diesel fuel, some of the engines are available in the full Diesel type; some in the semi-Diesel type.

For those who desire engines somewhat heavier and more powerful than the multi-cylinder units already described but at the same time lighter and higher speed than the horizontal units, at least one manufacturer has developed a two-cylinder vertical unit that can be supplied either as a natural gas or as a Diesel engine, and requiring but two cu. yd. of concrete in its foundation. This engine develops in excess of 60 hp. at a maximum rating pulling speed of 600 r.p.m. and 35 to 45 hp. at pumping speeds of from 300 to 400 r.p.m. Several of these engines are in service in the Texas-Oklahoma fields and the type apparently meets with popular approval.

Auxiliary engines of a still heavier type with strokes ranging from 8 to 12 in. and speeds from 450 to 800 r.p.m., have

*Substance of paper read before the California Natural Gasoline Association, January 3, 1935.

also been developed. In size these range from 30 to 300 hp. at reasonable b.m.e.p. ratings of between 65 and 70 lb. per sq. inch. Engines of this type are being widely used in irrigation, pipe line and generation work and will undoubtedly be adopted as refinery auxiliaries as and when refinery engineers become more engine-minded.

In selecting engines of this type, operators should compare the units offered, not so strongly upon catalogue ratings, but upon a common b.m.e.p., and piston speed basis. Some manufacturers rate their engines rather closely to the power developed on test; others, more conservative, rate them according to the load they can be expected to carry continuously without undue difficulties.

Not only have many interesting high-speed units been developed for auxiliary purposes, but some builders have turned their attention to the development of higher speed compressor units. Some of these feature vertical engines and compressors; some vertical engines and horizontal compressors, while one design makes use of the V-engine incorporated in one unit with a horizontal compressor. It is urged in favor of these designs that the equipment requires less floor space and foundation yardage than the slow-speed horizontal designs. It is doubtful if the actual manufacturing cost per unit of power will be any lower for these units than for the heavier horizontal units, this on account of the multiplicity of parts resulting from the multi-cylinder design.

Installation costs will undoubtedly be lower, maintenance costs higher, than for the heavier horizontal units. Crossheads not being practicable on this type of engine, power cylinder wear can be expected to be more rapid than in those designs wherein crossheads are incorporated. Before general acceptance it will be necessary for these lighter units to prove their ability to withstand the abuse to which oilfield compressor equipment is subjected, more particularly their ability to carry heavy overloads, and to withstand the shocks caused by the entrance of liquid into the compressor cylinders.

Let us consider the second of the methods of obtaining more power per dollar of cost, that of increasing the piston speed of existing units. From the builder's standpoint this is undoubtedly the least costly method that can be used. Many of you will remember that less than ten years ago the standard speed of practically every 20-in. stroke gas-engine-compressor unit on the market was 180 r.p.m. Some operators, pressed in emergencies for more power, voluntarily operated such equipment at speeds up to 200 r.p.m. At this excessive speed vibration and bearing loosening was in many cases experienced, but engine builders, observing that no serious damage resulted and pressed by highly competitive conditions, made some changes in the balance, the bearings, and the weight of the moving parts and began to rate their units at 200 r.p.m. The major parts of most of these engines remained, however, as originally designed for 180 r.p.m.

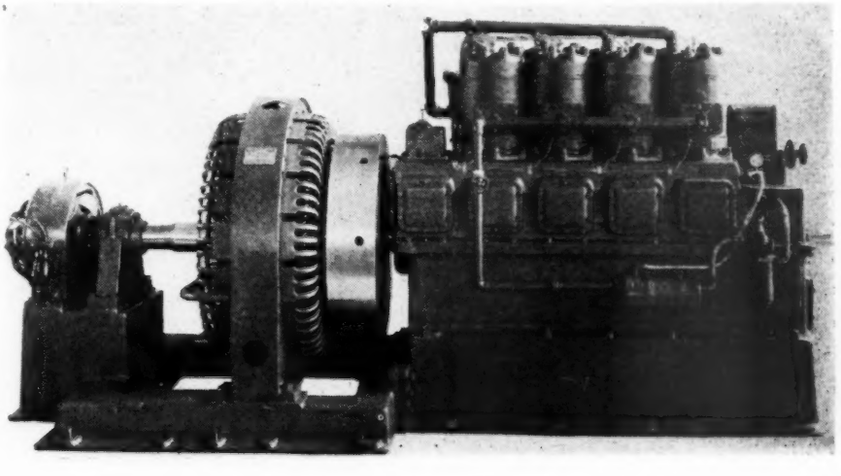
At the present time there are indications that competitive conditions have reached the stage where there may be a tendency again to increase the speed of this type of unit.

To many operators, increases of five to ten per cent in speed of existing units may seem of small moment but to those who realize the full meaning of the terms, "Inertia of moving parts" and "Unbalanced inertia forces," such changes are loaded with all sorts of grave possibilities. Briefly, the inertia of a body may be defined as its tendency to remain in its present state of rest or motion. In plain language this means that a moving body wants to keep on moving and will keep on moving until brought to rest by some restraining force. In an engine or compressor this restraining force must be very rapid in its action at the end of the stroke. The exertion of this restraining force subjects practically all moving parts, such as piston rods, connecting rods and crossheads to heavy strains. It also subjects stationary parts such as bearings and frames to the same heavy shocks and strains. When it is known to the person considering such matters that these forces vary as *the square of the speed*, not merely as the speed, and that a ten per cent increase in speed creates an increase of 21 per cent in the stresses to which most of the parts of the unit are subjected, he has full reason to pause and reconsider the advisability of such a move. Some of the results of excessive forces of this nature with which many operators are already familiar are:

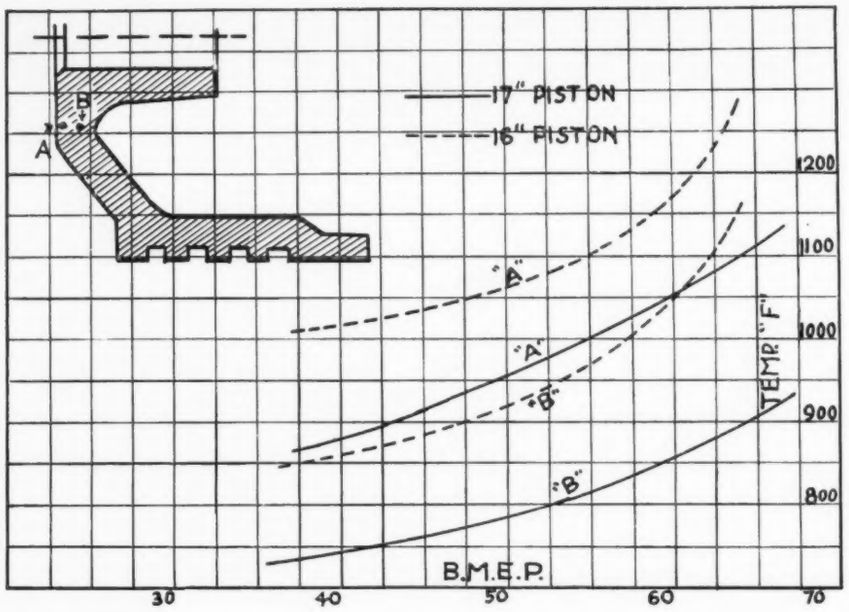
Moving of engines on foundations.
Continual and excessive loosening and pounding of bearings.
Broken bearing wedge bolts.
Broken connecting rod bearing bolts.
Broken connecting rods, crank disks, frames, etc.

Improvement of existing designs has constituted one of the main activities of engine builders during the past five years. The old-time horizontal open crankcase, exposed gear, oilfield pumping engine has been so altered in design and appearance that it is now in many cases an excellent auxiliary unit for gasoline and compressor plants. Crankcases and timing gears and valve gear are in many cases fully enclosed. Solid bearings poured in the main castings have been replaced either by roller bearings or by 2-piece or 4-piece babbitted wedge adjustment bearings. Automatic lubrication has replaced oil holes into which an attendant formerly injected oil (often very intermittently) by hand from the familiar copper or brass oil can. Governing has been not only improved, but perfected. Some vertical models have been developed that would make excellent power units for centrifugal pumps.

At least two manufacturers of horizontal 4-cycle-engine-



A 4-cylinder natural gas generator unit



Curves showing improved dissipation of heat obtained by a 17-in. power piston of modern design and improved engine-cooling

driven compressor units have made radical changes in power cylinder head design in order to facilitate cooling of both the head and the valves. Such improvements in cooling naturally result in ability to carry heavier loads.

Force feed lubrication of bearings, adopted in at least two instances not only lessens bearing maintenance expense, but, by improving the overall mechanical efficiency of the unit, increases its ability to deliver more compressed gas per indicated engine horsepower.

Honed power and compressor cylinders are now supplied by at least two manufacturers, possibly by more. To go into a discussion of the merits of this process of finishing cylinder barrels is beyond the province of this paper. Suffice it to say that cylinders formerly bored with a manufacturing tolerance of .002 in. to .005 in. can now be successfully honed to a tolerance of .0005 in. throughout their entire length. By wearing away the thin section of softened metal left on the cylinder walls by the boring mill, the honing process results in very hard cylinder walls with from two to three years added to the life of the cylinder through elimination of the "wearing in" process that is necessary with bored cylinders.

Probably one of the most striking improvements in engine design has resulted from the work of one manufacturer in the development of a 17-in. by 20-in. 2-cycle power cylinder with overhead exhaust. Five years of "cut and try" development work has resulted in the development of a power cylinder of this size with a resultant increase of five per cent in mechanical efficiency, a decrease in scavenging hp. loss of 25 per cent, the elimination of the necessity of injecting cooling water into the exhaust and the practically entire eradication of detonation. This last has been somewhat contributed to by the superior wall- and head-cooling made possible by changes in jacket design but is more largely the result of improved piston characteristics. The 17-in. diameter piston, contrary to all earlier theories, actually dissipates absorbed heat so much more rapidly than it was formerly dissipated by the older 16-in. diameter piston, that the temperature of the 17-in. piston head is actually more than 200 deg. fahr. lower than that of the 16-in. piston. This lower piston temperature naturally results in lower fuel temperature, with consequent elimination of detonation, and its attendant difficulties.

The thermal efficiency of the 2-cycle engine, as the result of improvement of the fuel injection apparatus that made its appearance in 1927, has been increased over the entire hp. range and is now favorably comparable, if not superior to, that of the most efficient 4-cycle engines. A test made on two engines, one a 4-cycle unit, one a 2-cycle unit, both 12½-in. bore by 20-in. stroke, all parts of the two engines being identical except the valve mechanism, reveals the following figures:

	Four-Cycle			*Two-Cycle*		
Per cent load	50	75	100	50	75	100
Heat in useful hp. per cent	16.3	21.1	24.9	17.0	21.6	25.8
Friction heat, per cent	4.2	3.8	3.5	2.7	2.3	2.1
Heat to cooling water, per cent	28.2	27.6	27.4	27.8	26.7	25.4
Heat to exhaust, per cent	44.0	39.8	38.1	41.8	39.3	37.6
Radiation loss and unaccounted for, per cent	7.3	7.7	6.1	8.3	8.0	7.3
Heat to scavenging, per cent				2.4	2.1	1.8
TOTAL	100.	100.	100.	100.	100.	100.

This test was made with the most accurate instruments available for the purpose, both engines having been operated for four hours before the test for purposes of stabilization. Loads were measured by a prony brake checked by indicator cards taken with a DeJuhasz indicator. The above figures not only show the 2-cycle engine to be the more efficient from both a thermal and mechanical standpoint, but would also seem to establish the fallacy of the belief that the modern 2-cycle engine requires more cooling water per hp. than does the 4-cycle type. Attention is also directed to the similarity of the figures showing heat to exhaust. Exhaust heat was computed from volumetric efficiencies from the indicator cards and the exhaust temperature.

Governing has been greatly improved, this being particularly true of the horizontal 2-cycle engine. The function of the governor is to maintain constant speed under changing loads. An engine that slows down with increase of load and speeds up with decrease of load is not well governed. While some gasoline plant operators have at times expressed satisfaction with such performance, it should be noted that such operation amounts to nothing more than running on the throttle, a method of operation that can be adopted to any engine of any type. Tests recently made in their plants by one of the larger oil companies revealed that as a general rule the vertical multi-cylinder engine governed practically perfectly, with the 2-cycle horizontals and the 4-cycle horizontals following in the order named. The 2-cycle units varied their speed about six per cent under 50 per cent changes of load, a fact made possible only by intensive study of the problem by the builders during the past few years.

On the whole it may safely be said that engine design has so improved during the past five years that purchase by oil companies of used equipment built prior to 1930 cannot be justified from an economical standpoint. At various meetings in the past, members of this Association have asked for lower-priced engines, for lighter engines, for higher compression engines, for more economical engines, and for auxiliary engines. The engine manufacturers have responded and all the engines asked for are available. Efficient engineers will carefully study the new designs before purchasing obsolete used equipment.

At the right can be seen the outline of what originally was an addition to this structure. It crumbled and was removed. Earthen passageways led to the main building

By
ROY W. PARKER
Oklahoma Natural Gas Co.

Termites...A Menace to Company-Owned Properties, But Controllable

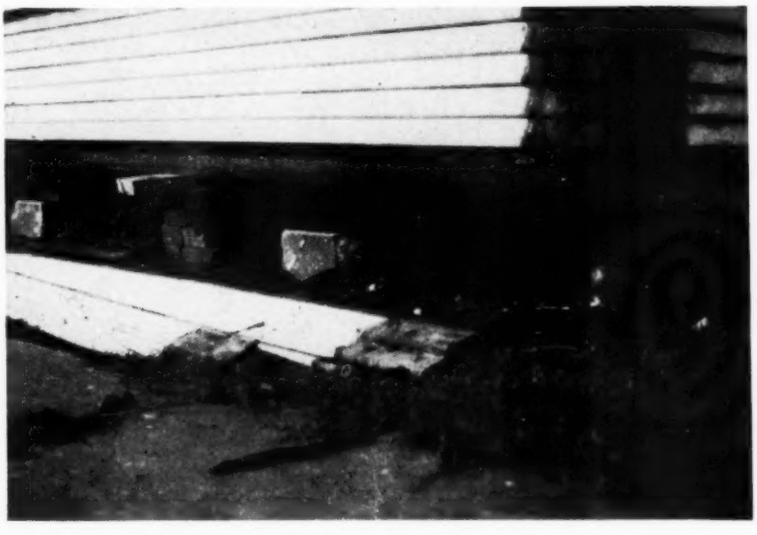
OIL and gas companies have millions of dollars invested in operating and stationary properties. When some outward force disturbs this huge investment, necessitating costly repairs and replacements, the natural reaction is to investigate and remedy. Soil corrosion problems have been recognized and fought for years. A more recent menace and one only vaguely appreciated except in some sections, is as serious and as widespread as it is inevitable. This threat is "wood corrosion" and one of the principal causes is *termites*.

An inventory of properties will show the large investment in wooden structures that are potential granaries for these wood-eating insects. There is evidence to support the contention that termite activity in some stage or degree at least, may be found in approximately 50 per cent of the standing wooden structures in the United States. Such destruction is estimated to cost $40,000,000.00 per year.

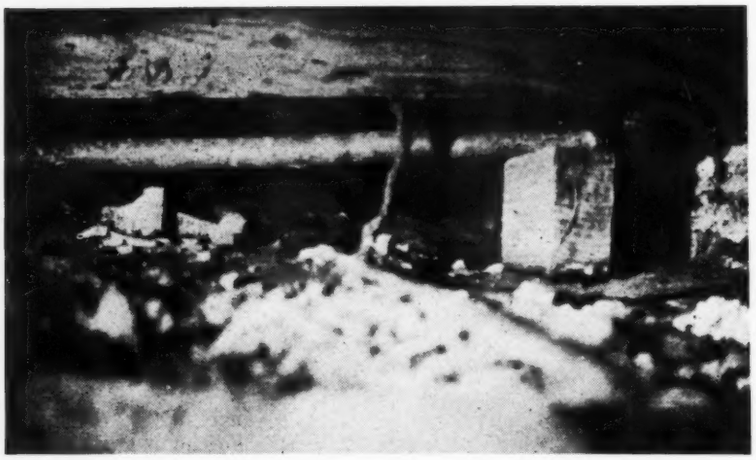
With about 50 species of the insect native to the country, they are found in destructive and ever-increasing numbers in every state in the United States, except North and South Dakota and Maine. The termite problem arises out of man's attempt to change the ordinary processes of nature by preserving for his own use, wood and its products, which it has been the immemorial function of the termite to break down and return to the soil.

There are two classes of termites, those that are subterranean in habits and the non-subterranean type. The former group uses the soil for its activities, while the latter group are fliers and attack from the air. This last class is only found in the southern parts of southern states.

The most common class works from the ground, consequently, they live and feed on wood that is on the ground or that which they are able to contact from the underground nest. Termites are ant-like, creamy white, soft-bodied insects that always conceal themselves within wood, in the earth, or within their earthen-like shelter tubes. Very few termites in this country have habits that make them conspicuous, or come above the ground in the sunlight except during the colonizing swarm. For that reason they escape notice until they become injurious. The destructive form, the workers, and their guards are really engineers. Even though they are blind, they are able to penetrate the hardest of woods, but always leave a thin shell to protect them from the light or detection. Moisture is necessary for their operations and if this pro-



An ideal place for termites—damp, dark, warm, and the bottom timbers on the ground. Direct contact was made with the subflooring. Infestation was general



A termite tunnel or tube extending from the ground to a flooring joist

tecting shell is punctured it is immediately sealed with mud.

Knowing their habits and probable habitat; that is, places under the buildings where it is damp, dark and warm, a general inspection can be made with reasonable certainty of getting the true condition. The following indications and observations should be noted when inspecting for termite location and/or damage. The emergence of a large number of the flying forms is an indication as well as a warning that the wood work is infected and the place of emergence indicates the approximate location of infestation. Large numbers of the dead winged adults or of the discarded wings will usually be found near the infected timbers following swarming. The swarming seasons are usually fall and spring. Grass and earth thrown out of crevices through which the insects emerge are also evidences of their presence. The presence of branching shelter tubes made of earth and finely-powdered wood on foundation timbers or other wood work, or on foundation materials, is another aid in locating the point of attack. Probe the wooden supports that rest on the ground, because what appears to be a sound stick might only be a shell. Examine the wooden scraps that are under the house, as this supply is often exhausted before the termite begins tubing to the wood above. Sagging woodwork or sudden failure of floors or walls is indication of advanced attack.

In case of the non-subterranean group, which infests wood directly, evidence that they are damaging wood is the impressed pellets of excrement which are expelled from the wood. Other evidences are holes, similar in size to BB shot, where the insect entered the wood.

Oil derricks, many of which are located in wooded sections, are often infected. In one chapter of "Termite and Termite Control" (University of California Press), a specific report is made on oil derricks and wooden towers inspected. Of 362 inspected 20 per cent were found to be infected from top to bottom, 40 per cent partially infected, and 90 per cent had some degree of infestation, the worst damage being done to the crown blocks, water tables, sills and legs. The dry-wood or flying species was responsible for most of the damage.

Generally speaking, there are two methods of controlling termites in infested buildings or wooden structures. The first is by making changes in construction and through the use of concrete and termite shields over foundation walls. The second is by chemical means. Obviously, the first is the most expensive, but when considerable repair work must be done those proofing materials might be used. When erecting a new building an additional investment of two per cent will make the house termite-proof. When chemicals are used the life habits of termites render impractical the control methods used for other insects, such as: (1) biological control by the use of enemies; (2) poison bait, as in ant control; (3) spraying, as in spraying trees for moths; (4) the poisoning of mosquito breeding grounds, and other means.

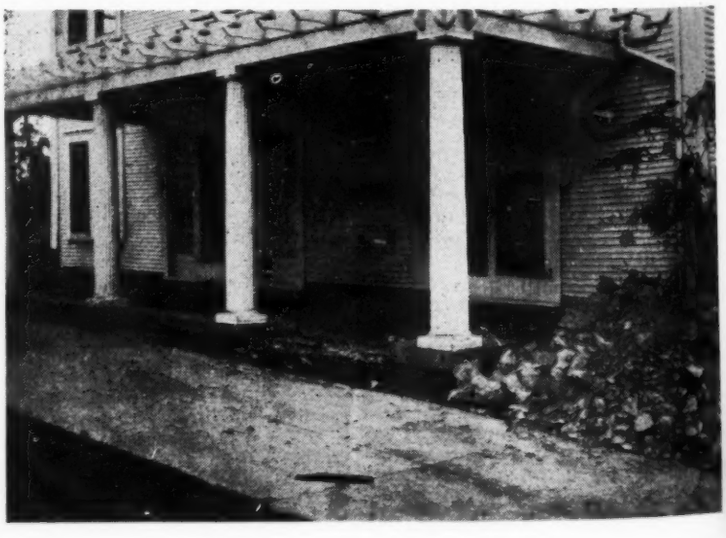
Before beginning the actual treatment all loose wood materials should be removed from under the house. All earthen shelter tubes should be broken down, marking their location for later work. This greatly disturbs the termite's normal living habits and cases have been known where they vacated for no other reason. If the spray method is used several sizable openings should be made at various places around the foundation wall. We are then ready for the treating. In that connection, the many claims made by the different agencies selling insecticides, sprays and poisons have led to considerable confusion in the minds of the average person. As a matter of fact, any recognized fly spray or ant powder will kill a termite. The difficulty lies in being able to reach the insect with such materials.

It is necessary then to use a substance that is not only toxic but penetrating. There are two groups, namely: those liquids high in toxic properties but low in penetration, and those low in toxic value but highly penetrating. Many of the water mixes belong to the first group and the petroleum mixes to the last group. Control agencies disagree on the chemical properties that should be incorporated in the ideal mix, each doing the job in his own way and using his own product. The following mix has been recommended:

50 parts of mineral spirits or crude oil
40 parts of crude carbolic acid—33 per cent. 45c/gallon in drum lots
10 parts of paradichlorbenzine. 24c/lb. in 50-lb. lots.

If flowers or shrubbery are near the building use:

50 parts of crude oil
25 parts of crude carbolic acid—33 per cent
20 parts of pine tar oil. 35c/gallon in 20's.
5 parts of paradichlorbenzine.

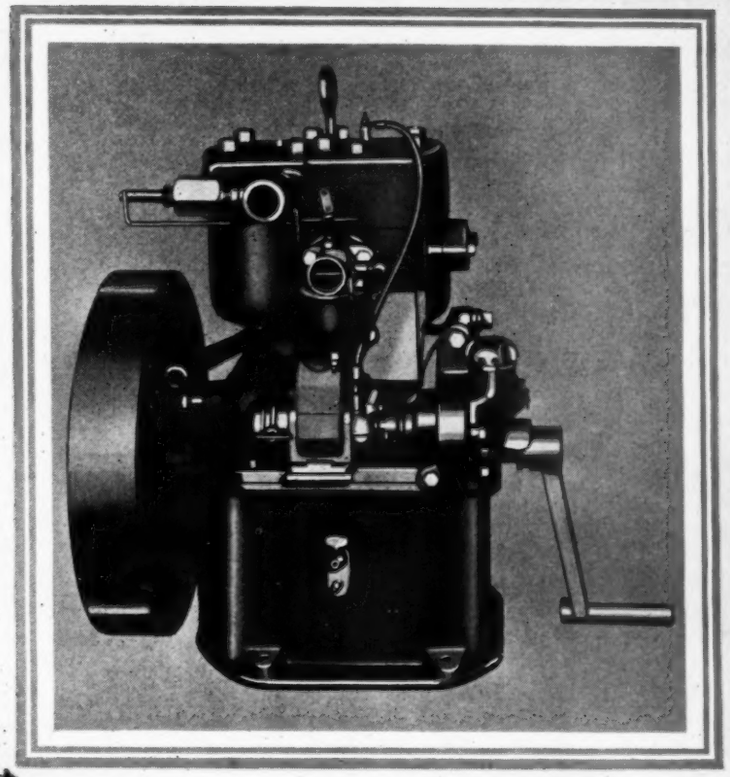


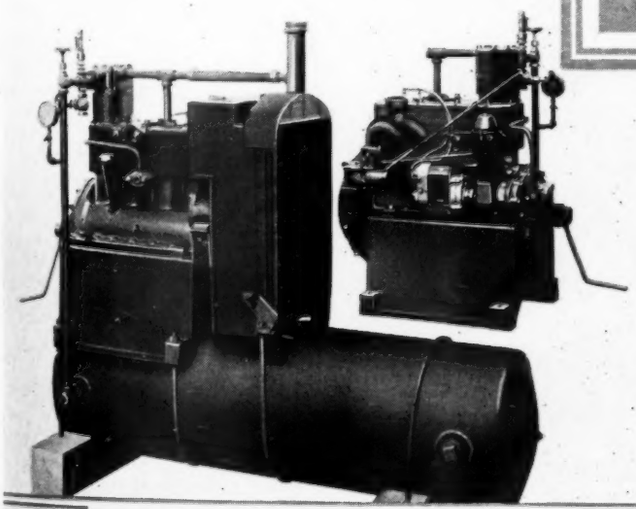
This entire concrete filled-in porch had to be removed to get to the source of attack

STARTING AIR COMPRESSORS

designed especially for starting gas and oil engines

THE ordinary air compressors which have been pressed into air starting service were originally designed for around 100 pounds discharge pressure. The customary air starting pressure for gas engines is 150 to 200 pounds and for Diesel engines 250 pounds. Type FD-2 is a combined gas or gasoline driven single-stage air compressor which has been especially designed to compress up to 250 pounds. The power cylinder and the compressor cylinder are cast in the same block. Both are water-cooled. This simple but modern self-contained unit is priced so that operators can afford to air start even their oil field pumping engines and eliminate the hazards of hand starting.





The Type FD-4 is a similar unit of somewhat more than twice the capacity. It has two power cylinders and two compressor cylinders operating two-stage all cast in the same block. It can be furnished with air receiver, cooling radiator and electric starter if they are desired.

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(Simply check desired Bulletin. Then use space at bottom for name, company and address.)

Another treatment recommended by the United States Bureau of Entomology contains a 40 per cent sodium arsenite solution cut to a 10 per cent strength with water. This solution is prepared by mixing one gal. of the 40 per cent solution with four gal. of water. If you do not make the 40 per cent mix yourself, the cost is $1.30 per gal. in drum lots.

Some other materials that have been used are ortho-dichlorbenzene, carbon disulphide, carbon tetrachloride, and benzol, named in the order of their value. Ortho-dichlorbenzene has the advantage of being safe to handle, as well as being the most effective of these chemicals for killing termites. The others, except carbon tetrachloride, are poisonous and highly inflammable.

Termites often use cracks in brick or masonry foundations as runways. A common method of treatment is to inject a generous amount of hot creosote between the surfaces of the foundation and the infested sill, and between the surfaces of the sill and studding. Poisonous dusts can be blown into these cracks and then the cracks sealed with hot asphalt.

The very toxic group of the element arsenic are often used in some form. It is very poisonous and when used with a good bonder and a base capable of dissolving a considerable amount good results should be obtained. Once the solution has penetrated the wood and precipitated the arsenic the termites' abode has been made extremely unhealthy. All the soluble arsenic compounds are poisonous to plants and animals; so caution must be used in such treatments.

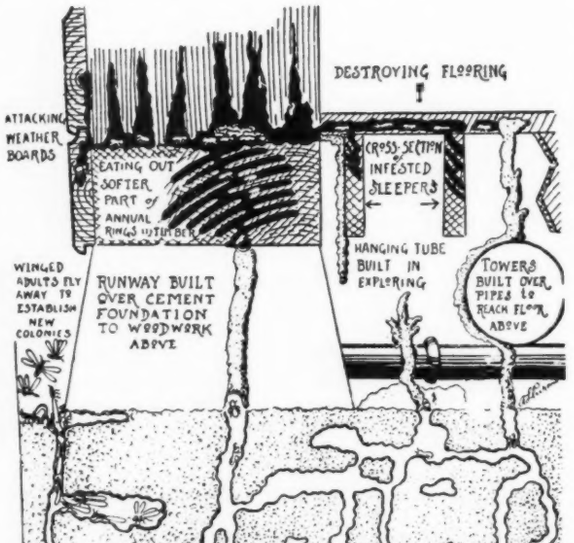
When preparing the ground for the erection of a new building the following treatments have been recommended. The materials are inexpensive and non-toxic and it is suggested that the solutions be applied generously.

(1) Copper sulphate solution made by dissolving four lb. of blue vitriol in five gal. of water. This is a good protection against fungus. Use wooden pail for mixing.

(2) Zinc chloride solution made by dissolving four lb. of zinc chloride in five gal. of water.

(3) Borax solution made by dissolving two lb. of borax in five gal. of water.

The actual treating of the infested wood as well as the ground under the house can best be done with a hand-operated pressure tank. After the preliminary work of preparing the building has been taken care of, the treating solution should be sprayed on all wood timbers under the house. A pressure of 75 lb. should be maintained in the tank to insure better penetration of the fluid. Thoroughly saturate the ground underneath. Drill a hole to the frost line in each nest, or termitarium, as indicated by the earthen tubes extending up the foundation wall, and pour a quart of carbon tetrachloride or carbon disulphide in these holes. Crude ortho-dichlorbenzene can also be used. It may be necessary to drill into the timbers or concrete to reach advanced infestation. Each case must be handled individually and the stage to which infestation has progressed will no doubt influence your choice of the solutions, as well as the amount and point of application.


DESTROYING FLOORING
ATTACKING WEATHER BOARDS
EATING OUT SOFTER PART of ANNUAL RINGS in TIMBER
CROSS-SECTION of INFESTED SLEEPERS
HANGING TUBE BUILT IN EXPLORING
TOWERS BUILT OVER PIPES to REACH FLOOR ABOVE
WINGED ADULTS FLY AWAY TO ESTABLISH NEW COLONIES
RUNWAY BUILT OVER CEMENT FOUNDATION TO WOODWORK ABOVE
KING
SOLDIERS GUARDING ENTRANCE
YOUNG CARING FOR EGGS IN CAVITY IN WOOD
EGGS
QUEEN ATTENDED BY WORKERS IN ROYAL CELL WITH SOLDIER GUARDS
THIS VIEW ON LARGER SCALE

(From University of California Bulletin)

Diagram showing the private life of the termite, and how he enters your property without your knowing it.

If a pressure tank is not available dig a trench two in. deep near the foundation under the house and pour ortho-dichlorbenzene in this at the rate of one gal. to ten linear feet. Paradichlorobenzene crystals can be used if treatment is necessary outside near plants or shrubbery. It is recommended that five lb. to ten ft. be used.

The unlimited permanency of a majority of the treatments now used is doubtful. Termite control companies usually give some guarantee of protection for a limited time, usually five years. A five-year test and inspection program is now being made at an experimental station in the East. Two inspections have been made but the results are not available at this time. No doubt many of the preparations have failed this soon.

There is little doubt in fact that an experienced control representative could do the job better, particularly if infestation was severe. But it may be that for economical or practical reasons this can not be done, then it seems worth the time and expense to make an inspection of company-owned buildings and remedial materials applied. Time alone will tell the permanency of the treatment. Periodic inspections must be made to determine whether your work has been successful. Providing for plenty of sub-structure ventilation and light at the time of treatment will add greatly to the possibilities. To treat termites, the operator must know their habits — the science of control — and how and where to apply the chemicals.

This article is written with the full realization that the termite problem is a serious one and not so easily checked or eliminated. However, damage in dollars and cents is rapidly increasing in the infested structures, and a general inspection followed by remedial measures seems the reasonable and logical procedure. Our fears have been exaggerated by some termite representatives; nevertheless, the menace does exist in some degree in many of the oil or gas properties.

I wish to acknowledge the assistance of local termite control representatives, particularly, Mr. Howard Zeigler, in the preparation of this article.

New Oil Concession in Kuwait

In a dispatch from Baghdad, the Financial Times reports that the Sheikh of Kuwait, who rules a principality on the northwestern coast of the Persian Gulf, has signed an oil concession covering all his territory. The concession is reported to grant sole rights to an Anglo-American group stated to be a combination of two powerful oil concerns. This report says that the British interest is held by the Anglo-Persian Oil Company and that the group will operate the concession through a British company named the Kuwait Oil Company. (Roy Atherton, Charge d' Affaires, London.)

The Manufacture, Packaging, and Shipping of Oxidized Asphalts

Article 2

By

CHAS. J. HOLLAND

SINCE much of the discussions and recommendations in this series of articles will be based on the author's experience with the design and operation of what he believes to be the first continuously-operated oxidizing plant ever built, in America or anywhere else, it is important to present at the outset its description and sketches of its essential parts.

Besides this one, there will be others to be described and commented upon before the presentation and analyses of the 15 basic principles of modern asphalt plant design and operation. In addition to short notes on certain European asphalt refineries, altogether there will be a total of four; two of which are in Texas, one in Germany and the fourth in Mexico. As means of distinguishing them they will be hereinafter referred to, respectively, as Plant No. 1, Plant No. 2, Plant No. 3, and Plant No. 4.

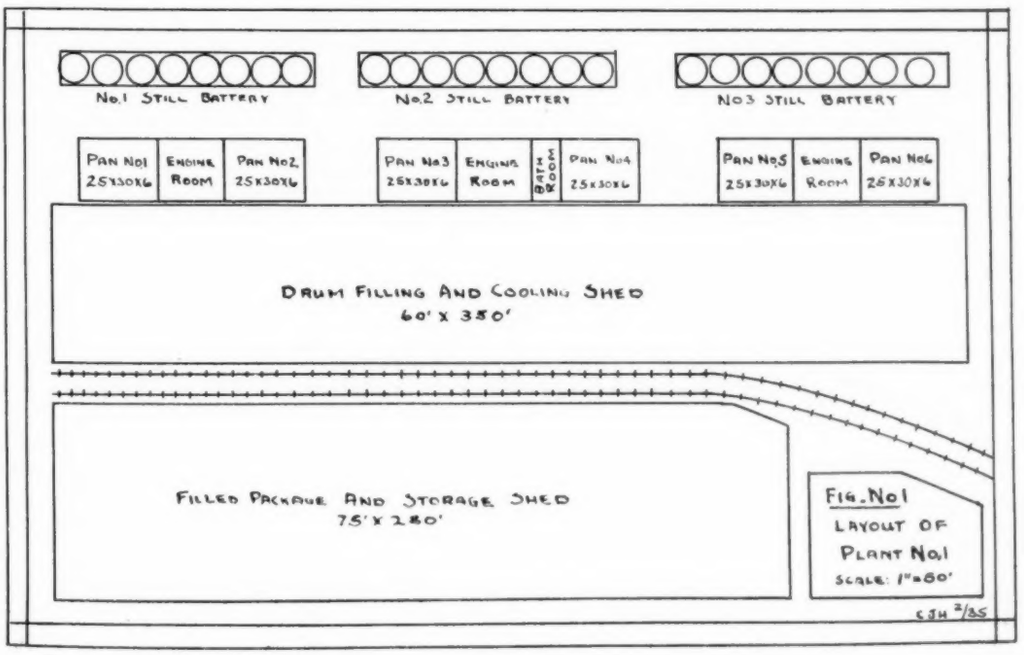
In 1915, when the author first entered the employ of the firm owning Plant No. 1, there was then in operation 16 10-ft. diameter by 10-ft. high vertical oxidizing stills. Each was equipped with a stirring device whereby, in addition to air and steam agitation, the hot liquid products in the stills could be kept in a constant whirling motion by mechanical means. The stills were similar in design and operation to two other types formerly used in the oil refining industry. One was used in the early days of the Lima, Ohio, oil fields where high sulphur crudes were treated during the batch distillation process with copper oxide. The other type was used for a long time for the aluminum chloride batch distillation process in the production of gasoline and kerosene from topped crude oils. All three types had approximately the same diameter-height ratio; i.e., one to one; were equipped for mechanical agitation, and were set upon brick foundations for heating with oil or gas fires underneath.

Having had some previous experience in the design and operation of continuous crude oil distillation shell still batteries, in 1916 the writer obtained permission from the management to redesign these 16 batch oxidizing stills so that the operation might be carried out continuously. This was done by the simple expedient of dividing the stills into two continuous batteries of eight stills each and of supplying each battery with a 4-in. flow-line placed four ft. from the top of each still. Thus it was possible to pump continuously the charging stock into the first still and to receive by gravity flow the finished oxidized asphalt from the last still of each battery. It was also possible, if desired, to produce continuously two grades of finished asphalt from each battery by drawing off one from the last still and another from the seventh, sixth, or fifth still, depending upon melting point required for the second grade.

In 1920, some two years after the writer had resigned as an employee of this firm, they built a third continuous battery of eight stills exactly like the first two batteries. Due to certain changes in supplies of crude oils and to improved fuel oil markets, in 1924, they decided to withdraw from the asphalt business. Some time later the entire asphalt plant was dismantled, all equipment junked or transferred to other uses, and for the past ten years this refinery has made no asphalt of any kind.

The continuous method of operating Plant No. 1 resulted in doubling the batch method capacity, in greatly reduced operating and maintenance costs, better products, and otherwise gave a much more efficient and satisfactory process.

As previously stated, so far as is known, this was the first continuous asphalt oxidizing plant ever built and operated in America or anywhere else. Oddly enough in these days of remarkable technological progress, it seems to have been both the first and the last. Not exactly in the categories of semi-continuous and continuous units, but certainly the last one to possess in its design and operation almost all the modern



fundamental features essential for simplicity, low operating and maintenance costs, uniform quality of finished products, and extreme flexibility as to operating conditions and grades of asphalts manufactured. Much additional knowledge has been attained through experience since 1916 about the manufacture, packaging and shipping of oxidized asphalts, but it is beyond contradiction that the chief fundamental principles were first developed and commercially applied in this Plant No. 1 design and have since been very little utilized by other asphalt refiners.

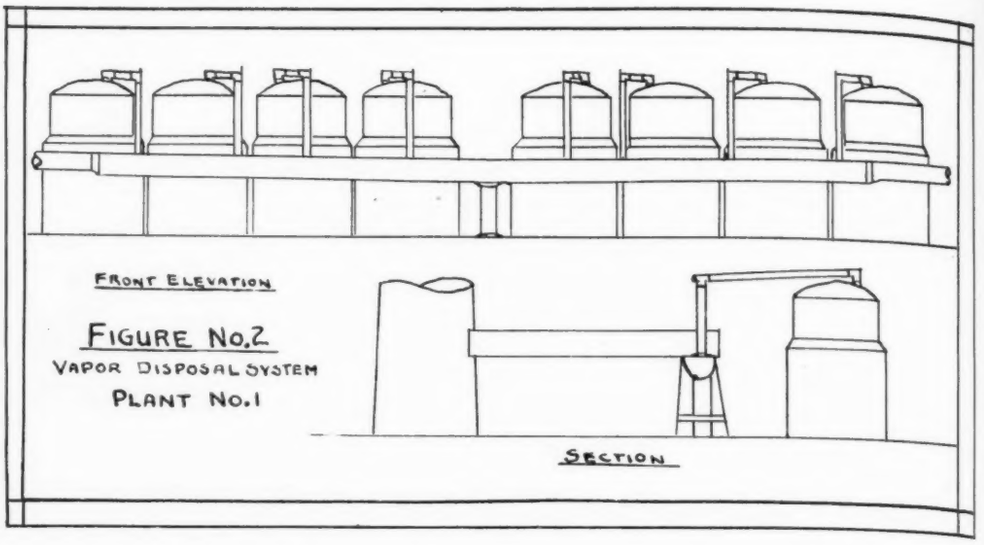


FIGURE No. 2
VAPOR DISPOSAL SYSTEM
PLANT No. 1

Characteristics of Raw Material and Finished Products

During the years of 1916, 1917, and early 1918, while the author was in supervisory charge of Plant No. 1, the business and output was at its peak. This came about through an occurrence connected with the World War. Many American firms using high melting point industrial asphalts in their manufacturing processes had previous to the war procured what they needed chiefly from the natural asphalts of Trinidad. Somewhat suddenly this source of supply was taken from them because of the British government commandeering for war use the ships of their nationals, including those who had a practical monopoly of the natural asphalt resources of Trinidad.

Two customers took about 75 per cent of our production. Both specialized in asphaltic roofing materials, cements, paints, and fillers for highway pavements of brick and concrete. They used for the most part grades B and C. To supply the demands of this trade only four grades of asphalts were produced. Their specifications, together with some typical analyses, are shown in the following tabulation:

TABLE I

SPECIFICATIONS AND TYPICAL ANALYSES OF PLANT NO. 1 OXIDIZED ASPHALTS

Grade	Specifications Ball and Ring M.P.	Penetration at 77° fahr.
A	175-185	35-65
B	235-245	15-20
C	250-265	10-15
E	290-310	10 or less

Typical Analyses of Asphalts and Charging Stock

Tests	ASPHALTS A	B	C	E	Charging Stock
M. P.	168	229	254	296	Liquid
Sp. Gr.	1.014	1.020	1.022	1.034	12-14 Bé.
Sol. in CS_2	99.31%	99.57%	99.30%	99.64%	99.69%
Sol. in CCl_4	99.37%	99.58%	99.42%	99.34%	99.41%
Sol. in 76° gaso.	74.50%	72.25%	70.05%	69.91%	97.30%
Fixed carbon	15.40%	16.50%	17.35%	19.60%	3.45%
Loss on evap.	0.13%	0.13%	0.07%	0.07%	0.15%
Penetration before evap.	31	14	10	6	Liquid
Penetration after evap.	25	9	3	1½	Liquid
Ductility	6	3	2.1	1.1	Liquid
Paraffin	0.56%	0.50%	0.48%	0.42%	0.60%
Flash Point	O.K.	400° F.	400° F.	O.K.	.....

The charging stock, called asphaltum oil, was obtained from the atmospheric fire heat and steam distillation of Texas crude oils containing practically no paraffin wax. The following figures show as a typical illustration the quality and quantity of products received:

CONTINUOUS SHELL STILL DISTILLATION
Texas Crude, 21.8 Bé. Gravity

Products	% by Volume Yield	Bé. Gravity
Standard White Stock	24.6%	32.5
Solar Oil	12.5%	28.0
Light Lube. Distillate	35.1%	22.5
Heavy Lube. Distillate	13.2%	18.5
Asphaltum Oil	12.9%	12.6

The required amount of asphaltum oil was pumped daily from crude stills to asphalt plant, some 3000 ft. distant, hot and through a 4-in. uninsulated line into the asphalt plant tank; uninsulated but equipped with closed steam coil heaters and of 2000 bbl. capacity. From this tank by means of steam-jacketed, steam-driven Kinney rotary pumps, the required amounts of hot asphaltum oil were continuously pumped into the first still of each of the three asphalt still batteries. The temperature of the asphaltum oil was kept close to 200 deg. fahr. at all times while in the 2000-bbl. charging tank.

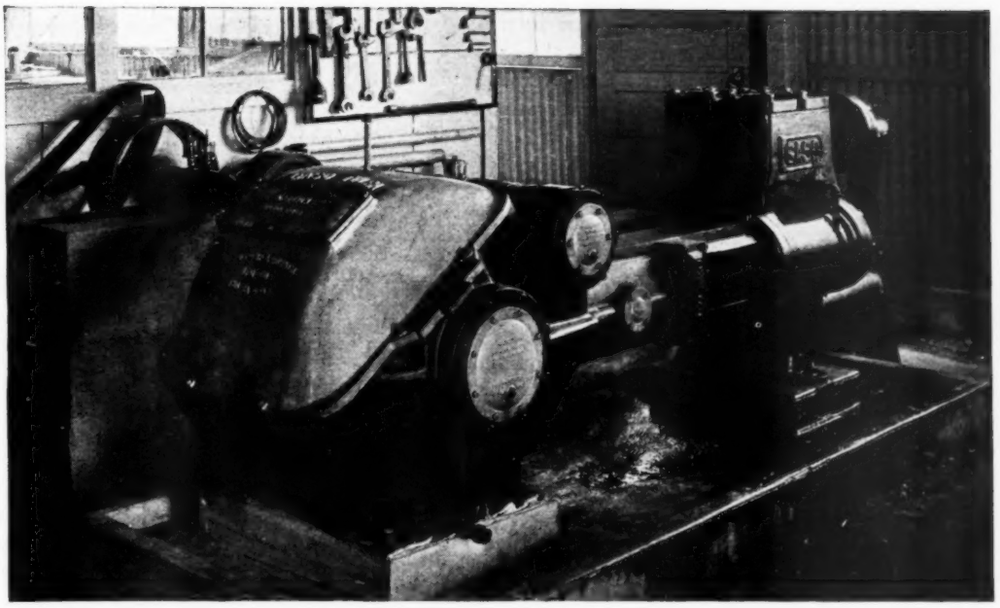
Plant Layout

The general layout and location of facilities may be observed from an inspection of Fig. 1. In this sketch the drum and wood barrel manufacturing plant and the vapor disposal system are not shown.

The drum factory was of the conventional type, using Bliss Company machinery and located alongside the drum-filling and cooling shed, next to still battery No. 1. It was a one-story building, where, as drums or barrels were needed for filling, they were transported by hand labor on to the floor of the drum-filling shed in front of the asphalt receiving pans. This, on first thought, may appear an extremely expensive method of handling empty packages. While it was more expensive than the usual mechanical conveyor, it was not a very costly affair. Cheap Negro and Mexican labor was used throughout the plant and these men were experts in handling empty and filled containers. With empties, one man could give a barrel or drum a quick twirl and send it rolling (not flat but on its bottom edge at a slight angle from the perpendicular) for a distance of 50 feet. Thus when empties had to go from the factory door to, for example, pan No. 4—a distance of about 200 feet—four men did the job. In an astonishingly quick time they could transport and stack in front of the pans several hundred empty barrels or drums.

Vapor Disposal System

A good idea of the vapor disposal system may be had from an inspection of Fig. 2. Each still had a large vapor line and all were manifolded to a covered iron trough where by gravity flow the solid, liquid, and gaseous products of oxidization



A horizontal enclosed-type Gaso power pump, equipped with American Hammered Piston Rings, at the Chief Station of the Casden Pipe Line Company at Burbank, Oklahoma.

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went into a concrete box, six ft. square by four ft. deep, located at ground level. In this box the solids were deposited and removed periodically by hand labor. The liquids were trapped off to the refinery sewage disposal system from where the oily portion was recovered to refinery fuel by conventional means. The vapors and gases coming out of the top of the box were led by an iron flue breeching into a concrete stack 160 ft. high. Originally, these gaseous products were vented directly from each still up 50 ft. into the atmosphere through 6-in. pipe uprights. When north winds prevailed, this system proved objectionable to workers' families residing in a colony about one mile away, due to the well-known characteristics of the noxious gases and vapors liberated during the oxidization process. As a successful and apparently the only practical means of removing this objection, in 1920 the 160-ft. concrete stack was built and put into service.

Down through the long trough serving all 24 stills there flowed constantly a 2-in. stream of water. This and the waste products were kept hot and agitated when necessary by having in the bottom of the trough a perforated steam line through which live steam was passed at intervals in order to keep the trough free of solidified deposits.

In the vapor line of each still immediately where it joined the still head there were two pieces of equipment used for keeping the vapor line free of solid accumulations of coke and tarry substances. One was a hand scraper made in the fashion of a spiral that could be moved up and down in the vertical part of the vapor line. This spiral was operated by hand by the stillman once or twice each shift. He did this by means of a handle that came out through the vapor-line top head, through an ordinary packing gland. The other piece of equipment was a ½-in. steam line connection whereby through a valve the stillman could at intervals introduce live steam into the horizontal section of the vapor line.

The succeeding article will conclude the description and discussions relating to Plant No. 1.

I-Beams in the Oil Field

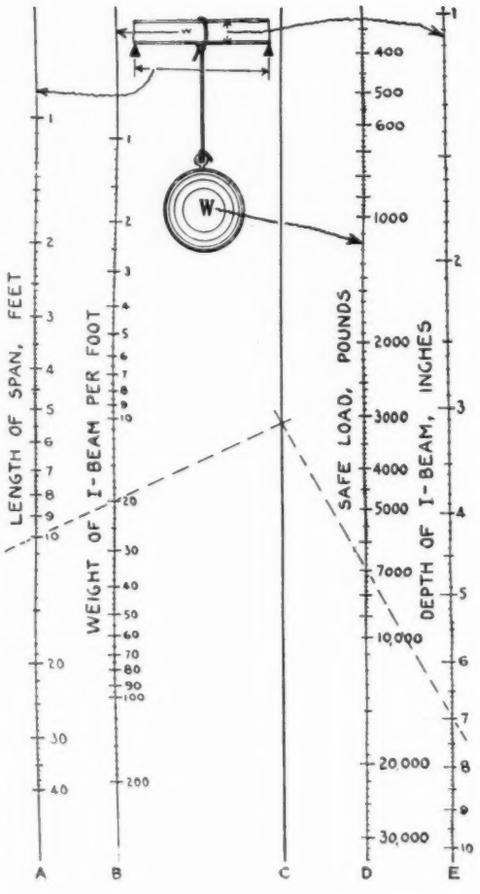
By
W. F. SCHAPHORST

How Much Will Any I-Beam Hold?

THIS chart answers the above question, which has been asked by many an oil plant man. No computations are necessary. The chart tells how much any ordinary I-beam will hold under the very *worst* condition, with the load concentrated in the middle of the span as shown by the sketch on the chart. The chart is based on concentrated loading for the sake of safety.

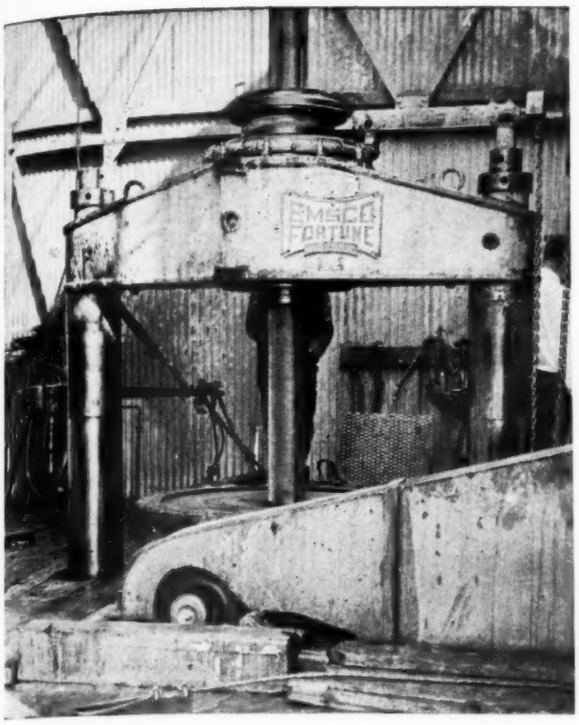
Let us suppose that a weight of 4000 lb. must be supported in your oil plant, or out in the field. A 7-in. I-beam, weighing 240 lb., is available. It is 12 ft. long, and therefore weighs 20 lb. per foot. The minimum distance between supports that can be obtained for the lifting operation is ten feet. Is the I-beam strong enough to lift the 4000-lb. load?

The dotted lines drawn across the chart show how the problem is solved. Run a straight line through the 10-ft. (column A) and the 20-lb. (column B) and locate the intersection in column C. Then, from that intersection in column C, run over to the 7-in. (column E). The intersection through column D shows that the I-beam will support 7000 lb. Since the load to be lifted is only 4000 lb., the beam is amply strong. In fact, the reader can easily find, by applying the chart, that a 4-in. I-beam, all other conditions being the same, would safely support the load of 4000 lb.



Similarly, it is easy to ascertain the maximum allowable span when the factors in columns B, D, and E are known. Or, the necessary weight per ft. of I-beam may be determined when the factors in columns A, D, and E are known. Lastly, the depth of beam is determinable when the factors in columns A, B, and D are known.

For loads that are "uniformly distributed"—not concentrated—the safe loads in column D may be multiplied by two. Thus, the above described beam will support a uniformly distributed load of 14,000 lb., or 1400 lb. per running foot.



This type of hydraulic feed uses the regular rotary table and equipment. It can be swung out of the way when not in use or can be easily removed entirely or installed at any time on the well.

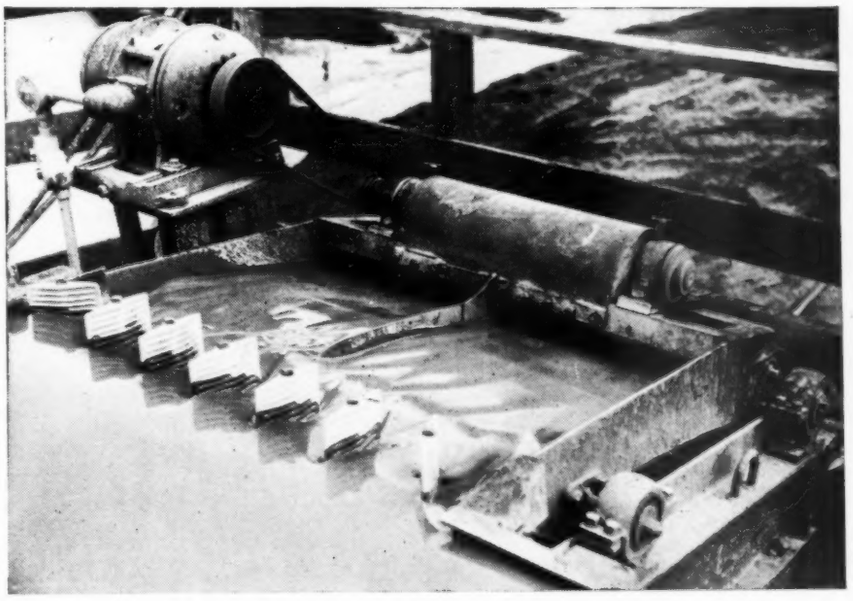
By

WALLACE A. SAWDON

Petroleum Engineer
Los Angeles, California

Handling High-Pressure Wells in California

WITH the great number of deep wells drilled in California it is natural that high pressures have here been encountered under widely varying conditions. Overcoming such pressures has required ingenuity in the application of methods and has influenced the development of equipment to meet the conditions imposed. The technique that has arisen for drilling through high-pressure zones has not been standardized; too many individual problems arise — not only in different fields, but in different wells in the same field and at different times in the pressure decline of a zone — to make any specific method the one that will best meet particular requirements. Moreover, experience gained by one organization may favor the application of certain methods and the use of certain equipment while that of another organization will make desirable a different solution to the problem.



A field installation of a McNeely vibrating screen on the mud system of a rotary drilling well.

The success that has accompanied high-pressure drilling operations in California, however, has shown the value of the methods and equipment used. This does not mean that specific cases do not cause considerable trouble. Individual well conditions, such as those caused by heaving shale or badly fissured strata, will often require unusual treatment that may be both expensive and lengthy in application. The methods now developed and the equipment now available, however, should meet any problem of pressure control. The selection is governed by the conditions encountered.

Mud control and the use of proper equipment, especially high-pressure fittings, during drilling and upon completion of the well, are of first importance in handling high pressures. While the weight of the mud is not relied upon for controlling the formation pressure in "pressure drilling," drilling fluid control is still a factor even when an external pressure is applied to the fluid column to offset high pressures encountered in the hole. This has been treated in detail in a previous article.[1] The use of high-pressure equipment, however, is fully

[1] "Pressure Drilling—A Developed Drilling Technique," by Wallace A. Sawdon, *The Petroleum Engineer*, February, 1935.

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*A better coring job consists of making the maximum recovery of good core and the maximum footage of hole possible while positively maintaining the factor of safety in the hole that is essential to efficient drilling operations. Cheapness or weakness at the bottom end of a long string of drill pipe is not true economy.

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Centrifugal separator at Ventura Avenue field reconditioning plant, which is recovering nearly 60 per cent of weight material from gas-cut mud

as important when using heavy mud for pressure control as when such control is exercised by pressure drilling.

Mud Control

Up to the present time, high pressures in the fields of California have been handled more extensively by heavy mud alone than by any other means. There is a growing tendency among some operating companies, however, to augment this by holding a back pressure on the fluid under certain conditions. High-pressure formations have also been drilled entirely with pressure-drilling methods as described in the above-mentioned article. Of outstanding interest, however, is the increased attention that is now being paid to constant and systematic testing of the mud and its reconditioning to maintain its effectiveness.

Mud control has undoubtedly been the means of completing a number of the deepest wells in California without costly blow-outs. It has not been so long ago that the weight of the mud was alone considered; and tests involved nothing but weight. The necessity for control of the colloidal properties of the drilling fluid is now recognized and the influence of colloids on the proper functioning of the mud has also been discussed in a recent article.[2]

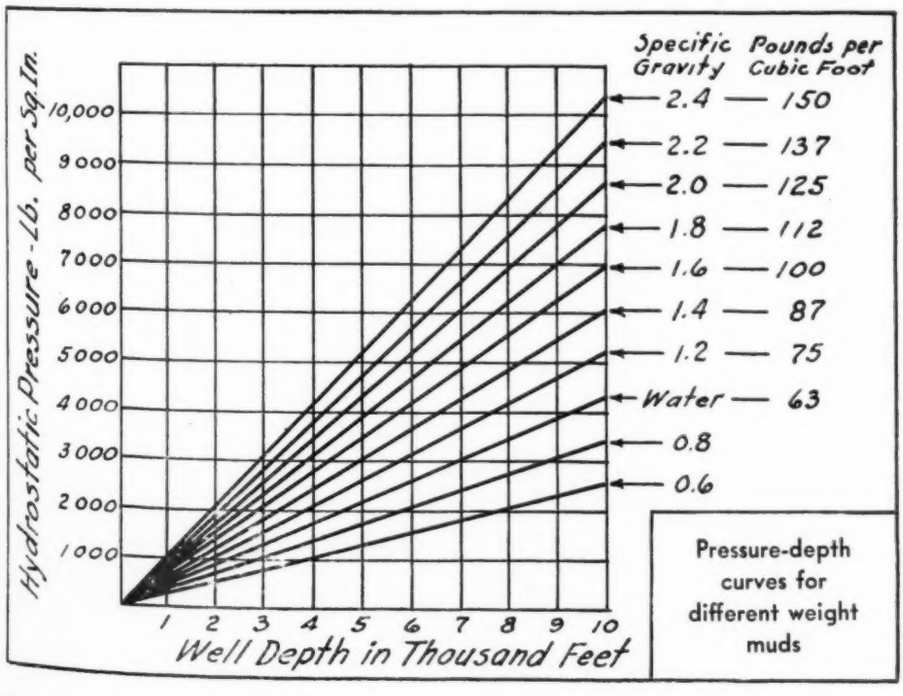
Almost all the larger operating companies are now using complete laboratory tests in addition to tests made for weight and viscosity at the well. The field tests are, moreover, being made a part of drilling routine and reports on viscosity and weight are incorporated in the log of the well. Automatic mud weight recorders are not being widely employed at present and most of the companies are using mud hydrometers to measure the weight. Funnel viscosimeters have been giving satisfactory results in determining viscosity and their simplicity and ease in use have made them popular. In fact, even some field laboratories use only the funnel although the Stormer viscosimeter is preferred for closer readings.

What the future of automatic mud weight indicators will be cannot be told. The other properties of the mud, especially the colloidal, are so influential in fulfilling all functions of a good mud that the weight alone cannot be the sole governing factor. In the General Petroleum Corporation's well, Berry No. 1, in the South Belridge field, a special apparatus was used to measure the weight of the drilling fluid at all times. But the apparatus also determined its consistency, sediment content and rate of settling. The careful measurement and constant control of the mud was an important factor in the drilling of this well, which reached 11,377 ft., a record depth at the time. High gas pressures had to be overcome and during the drilling of the greatest depths the mud was kept between 104 and 112 lb. per cu. foot.

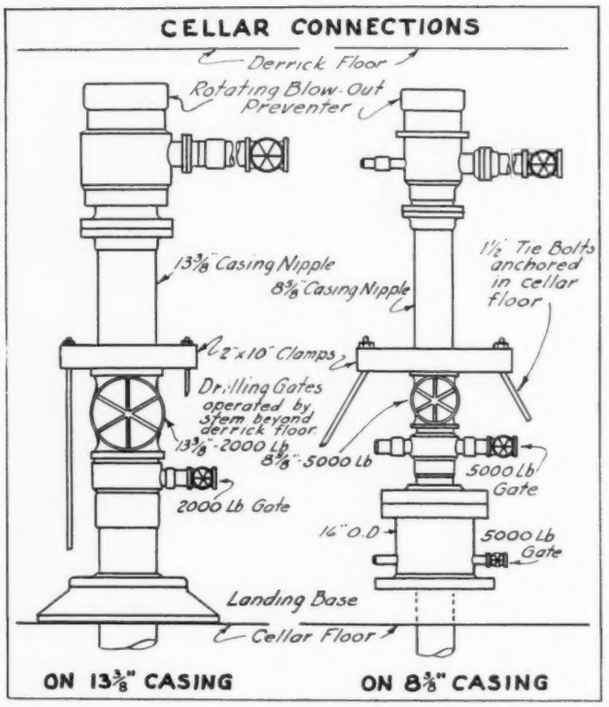
The maximum weight to which a mud can be built is mainly limited by the viscosity. The colloidal properties of the fluid are principally responsible for this viscosity but the addition of inert matter in the form of weight material adds to the viscosity. Colloidal properties are requisite in a good drilling fluid and are especially necessary when a great amount of inert material must be held in suspension. When the viscosity is too high, it may be unpumpable; and it must be remembered that a highly viscous fluid will gas-cut more rapidly than one of lower viscosity.

In the Ventura Avenue field, mud weighing 120 lb. per cu. ft. has been used successfully with the addition of only two per cent of colloidal material. The original mud from which this was made, however, was native clay and there were probably additional colloids held

[2] "Control of Colloidal Properties are Vital in Mud Conditioning," by Wallace A. Sawdon, *The Petroleum Engineer*, February, 1935.



Pressure-depth curves for different weight muds



Typical cellar connections used by one major company on wells in North Dome, Kettleman Hills field, California.

over from it to make the percentage of colloidal matter three per cent or more. The use of drilling fluid weighing as much as 150 to 160 lb. per cu. ft. has been tried in a well in India. In this, the claim has been made that salt water in the hole robbed the fluid of its colloidal properties and the inert solids settled to the bottom and froze the drill pipe. With mud of this weight that is pumpable, it is doubtful if the weight material can be kept in suspension with any degree of satisfaction under all contingencies that will arise during the drilling of a well.

In drilling the Lillis & Welch well No. 1 in the North Dome of Kettleman Hills, an 82-lb. mud was used until a depth of 10,200 ft. was reached; but the pump pressure was sometimes as high as 1400 lb. per sq. inch. The brown shale there encountered would not mix with the fluid and it was found that the cuttings could not be returned without the use of an admixture. An admixture providing both weight and colloidal properties was then added and the mud weight increased to 90 pounds. The pump pressure was reduced to 1225 lb. and the rate of circulation increased. This well was drilled to nearly 11,000 ft. and has recently been taken over by the Union Oil Company. Further drilling and completion is felt to be mainly a mud problem.

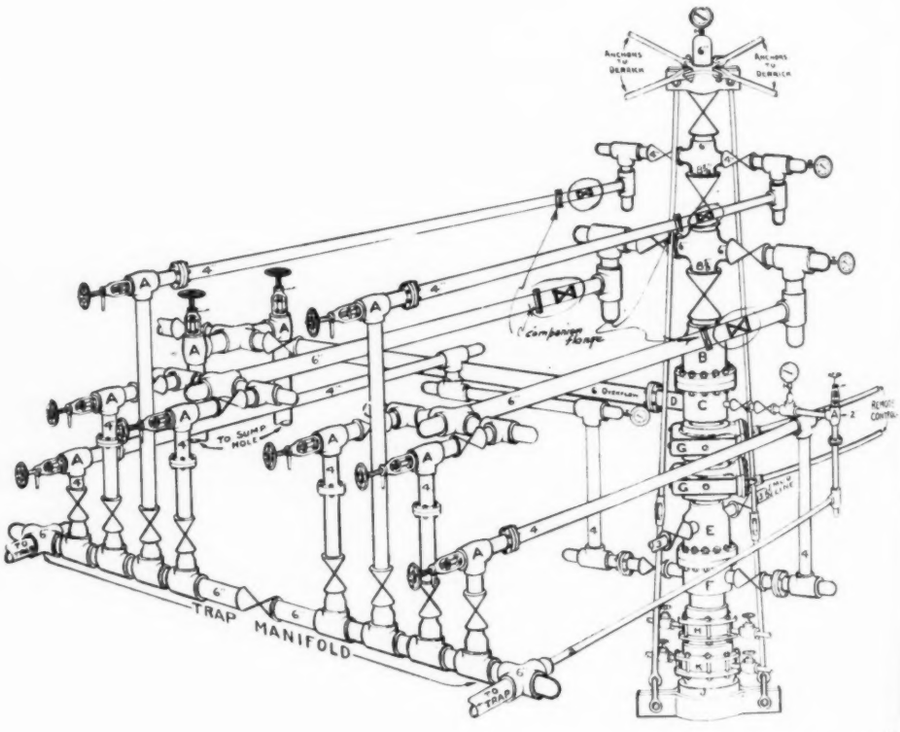
Gas-Cutting

While the pressure applied to a gas-bearing formation by the weight of a column of fluid may exceed the formation pressure, there are many factors that can seriously affect the actual application of this pressure on the face of the sand. In the first place, there is an upward movement of the mud during circulation. Then, as hole is made, there is a release of gas. Even water that has been forced into the sand may force out more gas when an unfavorable differential occurs. High colloidal properties help to seal off the wall of the hole and this fact should be considered in conditioning heavy mud. Yet a too viscous mud will tend to retain the gas when it reaches the surface.

Considering weight alone, the gas entering the mud fluid reduces the weight of the column both by expansion due to the pressure decreasing in its travel up the hole and by its physical mixture with the mud itself. The free gas is instantly released when the returns reach the surface; but the gas absorbed in the fluid or, in some cases, the gas actually adsorbed by the solids, is likely to remain in the mud and cause re-circulation of a fluid already gas-cut before being pumped down the hole. Vibrating screens have been found to assist greatly in releasing the gas absorbed by the mud fluid and in many cases have prolonged the life of the mud that came out of the hole badly cut with gas.

Systematic testing has been found necessary in wells in California to prevent re-circulation of gas-cut mud. In addition to that, precautions in drilling are followed to eliminate the hazards arising from leaving a hole full of light mud when the tools are pulled out. In a well now drilling at 7000 ft. in the Ventura Avenue field, 50 bbl. of reconditioned mud are introduced when changing bits. A greater quantity is pumped in when the tools remain out of the hole for a greater length of time, the amount being proportional to the time, and in some cases being as high as 200 barrels. The tools in this well make a swabbing action in coming out and actually pull gas into the hole. The mud being used is 95 lb. per cu. foot.

Precautions taken before pulling the drilling string out of the



Casinghead connections on Associated Oil Company's well Whepley 1, Kettleman Hills, California

hole have aided greatly in keeping the pressure under control. Circulation with heavy mud for some time after rotation has stopped will replace badly cut mud with a fluid that is better able to offset the gas pressure of the formation. It is a practice with most companies when drilling high-pressure zones to fill the hole with mud to take the place of the space occupied by the drill pipe as it is withdrawn from the hole. Why this practice is not universal cannot be explained.

A rather extreme treatment is necessary in some of the deeper wells. As an example, particular care was taken with Associated Oil Company's well Lloyd No. 83 in the Ventura Avenue field, from which production was obtained at a depth of 9710 feet. In this well, three 14 x 7¼ x 14 mud pumps were placed in the cellar and due to their position had a head of about ten ft. on the suction. The maximum pressure reached was 1500 lb. per sq. in. and circulation caused no trouble. At the lower depths, however, it was very difficult to get the tools out of the hole without the well blowing in. The large volume of gas encountered under high pressure would gasify the mud fluid until it was so thin that the well would start to flow. Heavy mud was therefore circulated for some time before the drill pipe was started up the well and in many cases it took as long as two days to come out of the hole.

In drilling this well, the mud from the company's classification plant was used until the lower depths were reached. When the pressures encountered became high, however, weight material was added and the mud kept at about 95 lb. per cu. foot. Most of the deeper drilling in the Ventura Avenue field is done with mud of about this weight. Some of the companies, however, have an emergency supply of mud weighing up to 120 lb. per cu. ft. on hand at the well to meet any contingency; also, in many fields a supply of highly concentrated colloidal liquid is placed at the well since this admixture is more readily introduced into the mud stream in liquid form.

Central Mud Plants

The large mud classification plant of the Associated Oil Company at Ventura has been described in detail in many places. The mud from this plant is used on all the company's wells in that field but due to the plant's wide application, admixtures are generally added to the output of the plant when drilling through high-pressure zones. Central mud plants are used by several of the companies in various fields in California

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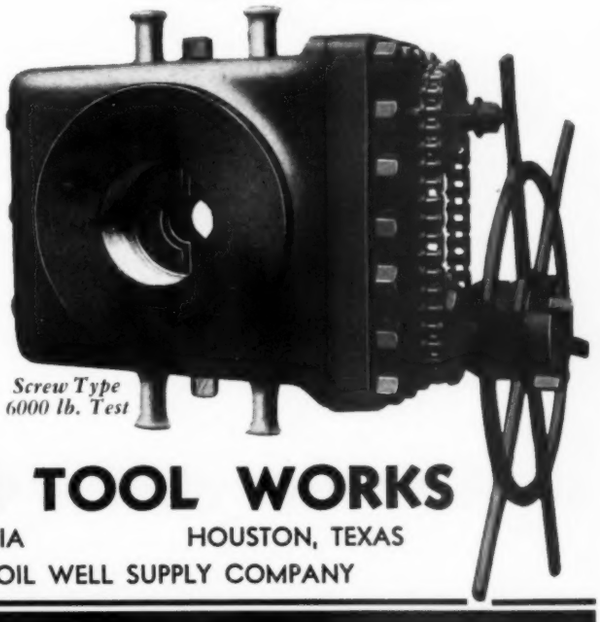

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and weight material is added both at the plant and at the well.

A reconditioning plant that has proved both economical and efficient has been used for the past year by the General Petroleum Corporation at Ventura. Of particular interest at this plant is the recovery of weight material from gas-cut mud. The mud for the deeper drilling is maintained at 95 lb. and when its weight is reduced to 82 or 83 lb. it is sent to the central plant for reconditioning.

The gas-cut mud here first passes through a vibrating screen and from there into a centrifugal separator. At the separator, the heavier portion is taken off and carried to one tank and the lighter portion to another tank. The heavy recovery has been found to consist almost entirely of weight material and water and since it will settle rapidly is immediately treated with a colloidal admixture and put into condition for use in drilling. The separator is automatic in operation and can be so regulated to give a mud of predetermined weight. The tailings are light mud and water with some colloidal material. But even when this lighter portion is good enough for use on shallow or low-pressure drilling, additional colloidal material is added. A recovery of nearly 60 per cent of the weight material from gas-cut mud is being obtained at this plant. Constant tests of the mud and proper treatment have made the plant most effective for mud control.

Surface Equipment

Cellar equipment on the well is of great importance in drilling through high pressures. The fittings used in "pressure drilling" have previously been described,[1] and on wells in California where pressure control is obtained by mud weight these fittings are usually tested to a pressure of 5000 or 6000 lb. per sq. inch. The arrangement preferred by the various companies is, of course, somewhat different but the present trend is to use a minimum of two drilling gates —one for a complete shut-off and the other for a shut-off around drill pipe.

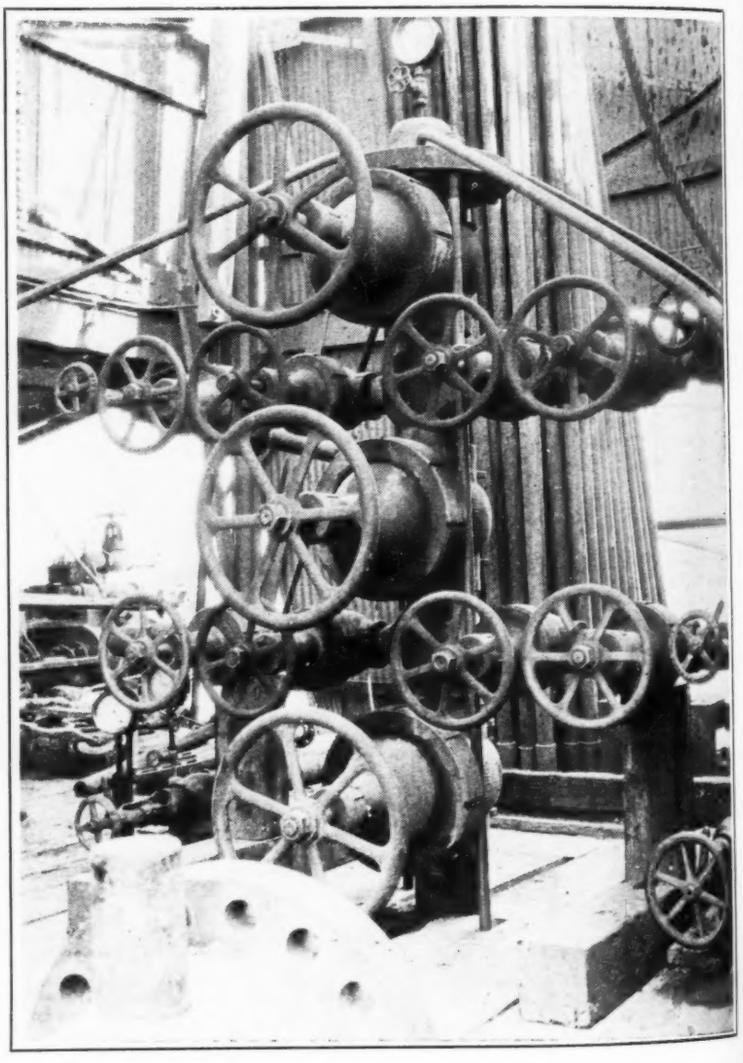
Blow-out preventers, both of the rotating and non-rotating type, are widely used. Mud crosses tested for high working pressures are essential and are being provided for both the introduction of mud while pulling out and for other contingencies. When holding back pressure on the fluid column, regulation is being obtained to a great extent by adjustable flow beans. Due to cutting action of abrasives that come with the returns from some formations, the flow beans are equipped with bushings with hard-facing material around the hole. The flow beans are also used as valves in some installations but are especially necessary for control of flow when back-pressure regulation is kept within close limits.

There are, of course, many special types of drilling heads being used while going through high-pressure zones. They all involve the principle of pressure control and aim to meet the contingencies that will arise when drilling through any high-pressure formation. Many of the companies, however, have emergency equipment at the well and often have some device that can be latched to the drill pipe or Kelly with a packer that can be set by the weight of the string. Packers at locations in the cellar are used according to the preference of the operator.

In addition to standard drilling gates, there are also specially designed emergency valves in use. One type is a flapper valve, placed below the master gate and shutting automatically when any upward flow of mud occurs while the tools are out of the hole. Remote control by a stem to beyond the derrick floor is becoming almost universal for operating the drilling gates on wells where high pressures are expected.

High-pressure equipment, however, must be available for use at all times—and not taken off the well when there is the slightest likelihood of its use being necessary. Very recently this fact was forcibly emphasized by a wildcat well in the Semi Tropic district west of Wasco. About 3000 ft. of 13⅜-in. casing was landed in 18⅝-in. in a spool head. The control gates were taken off and the hole was being cleaned out with light mud in the hole. The well blew in—and approximately 1000 ft. of drill pipe were blown out of the hole. It then caught fire but shortly sanded up and put itself out. The rubber packing on the spool was fortunately not injured by the fire.

There seems to have been little trouble experienced in running casing into high-pressure wells although due precautions and careful operation are being rigidly followed. When control gates equipped with drill pipe rams are being used, the complete shut-off gate is closed and the drill pipe rams on the other gate are replaced with others of the proper size for running the casing. It is the general practice to use either two float collars or a float collar and float shoe on the casing to float it in. In the Lillis & Welch well previously mentioned, the operator asserted that an important function of the



Christmas tree on Superior Oil Company's well Hoffman No. 1, Kettleman Hills, California

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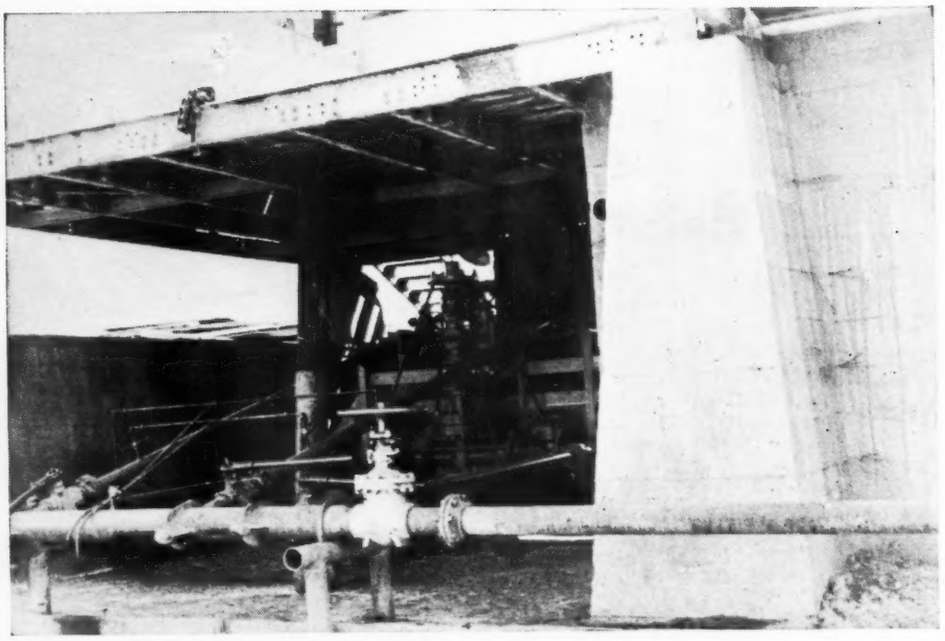


The christmas tree below the derrick floor on a well in the Kettleman Hills field. These flow connections were installed in the cellar after the high-pressure drilling fittings were removed. Note the foundations and steel floor beams

floating equipment was to displace the fluid so that circulation could be maintained while the casing was being run.

Snubbing devices for running drill pipe casing or tubing against pressure are naturally used when pressure-drilling methods are employed—as was brought out in the previous article already mentioned.[1]

The Belridge Oil Company, in drilling the high-pressure wells in the Belridge field, are using spool heads down to the last cemented string of casing. A 4¾-in. flow string is then run in and set on slips and a packing assembly under protection of the control gates. A riser, usually of 11¾-in. diameter, replaces the drilling connections up to the derrick floor and is flanged at the bottom to the casinghead and at the top for the christmas tree.

The flow connections used on completion of high-pressure wells differ with each company. Some of the typical ones being used in California are illustrated. These are placed either on the derrick floor or below the floor, according to conditions. Usually they are of 5000-lb. test or greater and are often made up and tested either at a company shop or at the plant of a manufacturer who supplies them. From the shop they are shipped to the field in completed set-up with only connections such as lead lines or manifolds broken for convenience in shipping.

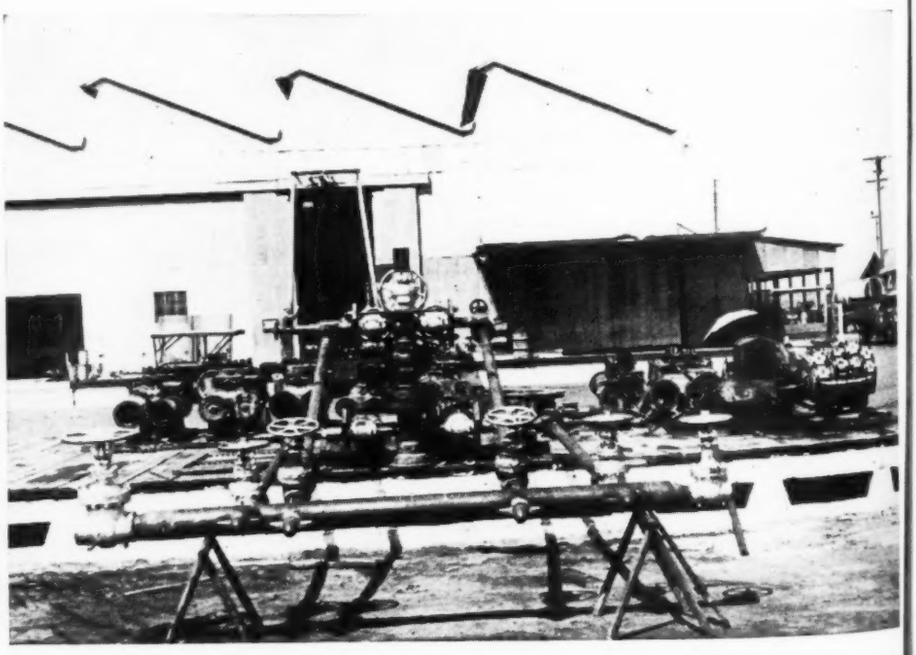
Present Methods in Kettleman Hills

While the pressures now encountered in the North Dome of the Kettleman Hills field are not so great as formerly, the methods of drilling through the high-pressure zones that must still be overcome show the result of experience. Typical of the cellar fittings and other equipment being used are the hook-ups employed by one of the major oil companies that has been very successful in drilling wells in this and other high-pressure areas.

Using as an example wells completed in the North Dome with a two-string casing program, a 13⅜-in. surface string is landed at approximately 1500 feet. This is run in with a float shoe and float collar and is equipped at the surface with fittings as shown in the drawing of cellar connections on page 54. Since excessive pressures will not be encountered while drilling through this string, only 2000-lb. fittings are necessary.

Drilling, however, is done with a rotating blow-out preventer; but in addition there are always available for immediate use emergency fittings adaptable to both the round drill pipe and the square Kelly. The control device used is of the latch type, which, after being placed on the drill pipe or Kelly, has its rubber packing expanded by the weight of the drilling string.

The water string of the two-string program is 8⅝-in., 36-lb. casing run with float collars and a float shoe. When this is cemented at approximately 7500 ft., the 13⅜-in. fittings are replaced with the 8⅝-in. fittings, also shown in the above-mentioned drawing. These are 5000-lb. test and are placed on the landing base at the top of the 13⅜-in. surface string.



The flow connections for a well in Kettleman Hills being tested at the shop of the producing company before shipment to the field

In drilling through the 8⅝-in. string, a rotating blow-out preventer is used with emergency fittings adaptable to both round drill pipe and square Kelly and available for immediate use.

Formation pressures are overcome through use of weight material in the mud fluid. Mud control is obtained by constant conditioning from information procured by periodic tests. The colloidal property of the mud fluid is also carefully checked and is regulated by laboratory tests that are conducted throughout the drilling of a well whether heavy fluid is required or not.

Gas-cut mud naturally requires even closer attention and the reduced weight thus caused must be corrected. The hazard from this cause is practically eliminated, however, by drilling through the rotating blow-out preventer and having high-pressure fittings to meet emergencies. Drilling gates are operated through stems carried beyond the derrick floor and thus add safety of operation to the means of control.

Whenever feasible, the cellars are built to accommodate the flow connections below the floor as shown in the accompanying illustration on page 58. Wells in the Kettleman Hills field are being equipped with 3-in. upset tubing and two lead lines take off from this and two from the 8⅝-in. casing.

The christmas tree, lead lines, and manifold are made up at the company's shop and there tested to 6000 lb. per sq. inch. Only the lead lines and manifolds are disconnected for shipment to Kettleman Hills; all the valves, fittings, flow beans, gauges, etc., being left as set up at the shop. One such assembly being tested is illustrated on page 58.

Drilling Equipment

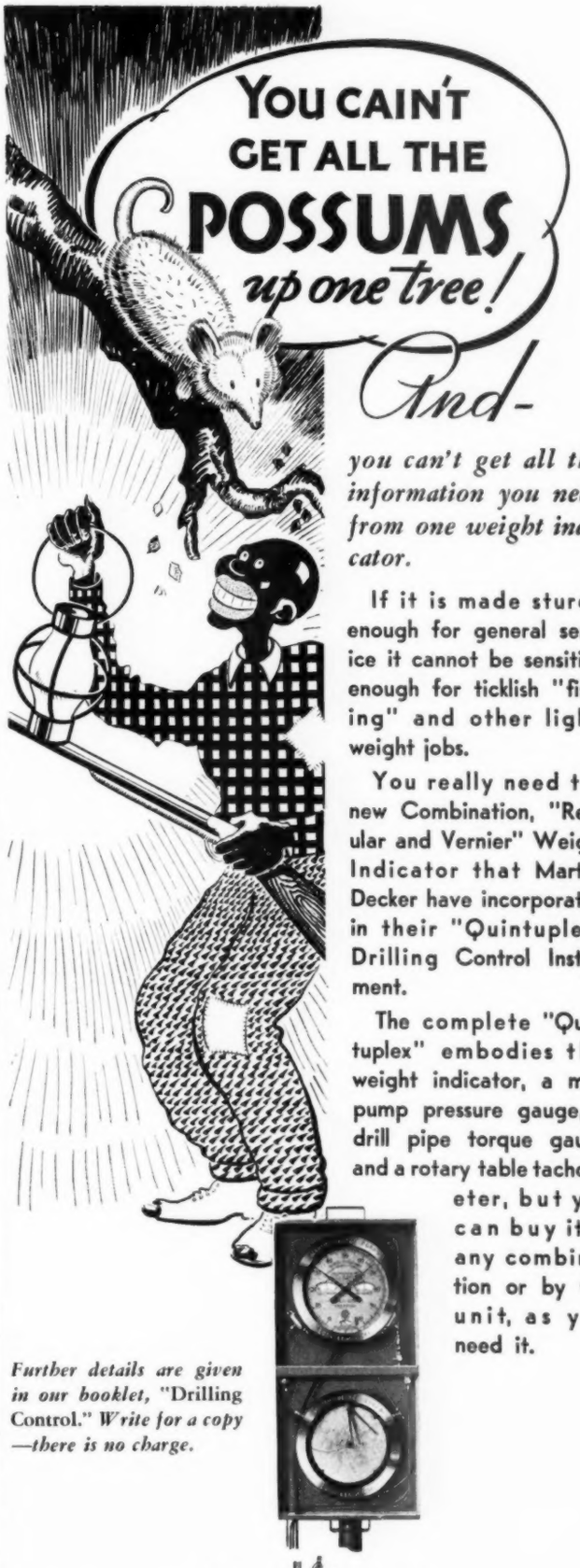
Due to the depths being drilled and to pressures encountered, drilling control is sought in putting down the high-pressure wells in California. Coördination between speed of drilling and control of pressure is being given due consideration and many companies drill slowly through high-pressure formations. Full-hole tool joints are being used to some extent and flush-joint pipe has aided materially in circulation where the clearance between the drill pipe and walls of the hole is small.

Weight control has so become a practice that due consideration of it is practically universal. Mud pump gauges, however, are important instruments and are generally used whether the control of pressure is by pressure drilling or by weighted mud. Speed of rotation is, in many installations, governed by tachometers and this speed is coördinated with the weight held on the bit.

Hydraulic rotary tables are being used quite extensively by some of the companies. The advantage of the hydraulic is self-evident when using pressure-drilling methods. Its close control of feed, together with other advantages, are well known to the industry, however, and need not be given in detail here.

A new type of hydraulic equipment has recently been used on a well in the Kettleman Hills field and the installation is shown in the illustration on page 51. With this equipment, a rotary table and other rotary equipment of the regular type are employed. The hydraulic is moved in when the hydraulic feed is desired and can be removed from the rig at any time. Also, it can be swung out of the way during any period when it is not wanted; and as easily be put back over the rotary table when it is to be used.

This design of hydraulic has a 10-ft. stroke. As can be seen in the installation shown, a blow-out preventer or drilling head can be placed directly beneath the derrick floor since the rotary table used is of the standard type. Like the hydraulic equipment that has been in use in California fields for a number of years, it is particularly adaptable to pressure drilling when this method is desirable.



you can't get all the information you need from one weight indicator.

If it is made sturdy enough for general service it cannot be sensitive enough for ticklish "fishing" and other lightweight jobs.

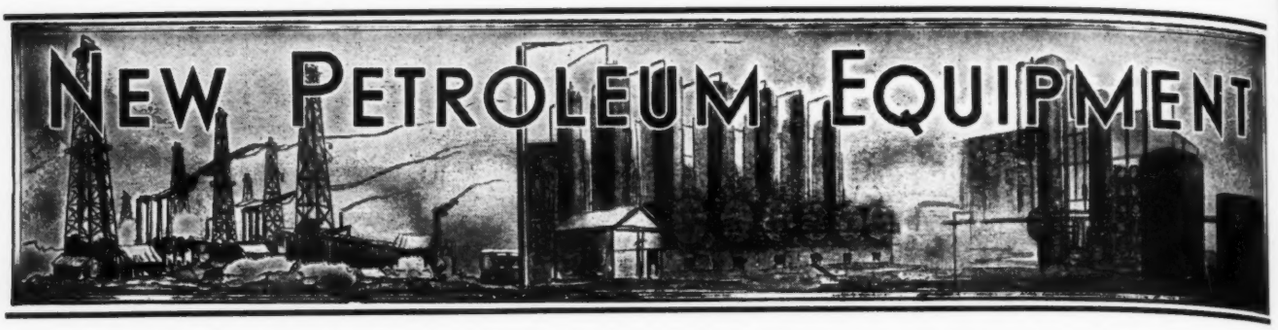
You really need the new Combination, "Regular and Vernier" Weight Indicator that Martin-Decker have incorporated in their "Quintuplex" Drilling Control Instrument.

The complete "Quintuplex" embodies this weight indicator, a mud pump pressure gauge, a drill pipe torque gauge and a rotary table tachometer, but you can buy it in any combination or by the unit, as you need it.

Further details are given in our booklet, "Drilling Control." *Write for a copy —there is no charge.*

THE WEIGHT INDICATOR
MARTIN DECKER CORP.
LONG BEACH CALIFORNIA

San Joaquin Valley: A. F. McQUISTON, Oildale, California
Mid-Continent Distributor: REED ROLLER BIT COMPANY, Houston, Tex.



Shaffer Boomer

A NEW load binder that is said to literally "walk up the chain," taking up as little as a half a link at a time with three positive locking positions, enabling the driver to tighten a load without loosing the slack, is manufactured by the J. E. Shaffer Company, Tulsa, Oklahoma. The standard size will take a ⅜-in., $\frac{5}{16}$-in. or ¼-in. chain, while the heavy-duty will take ½-in. or $\frac{7}{16}$-in. chain. The middle of a chain is threaded through the body. The opposite chain end is fastened into the end hook of the boomer, using the handle as a ratchet. The Shaffer Boomer has many other uses, such as pulling up a well, and connecting rod lines, in fact may be used on anything to be pulled. Its light weight and the ease with which it makes possible the accomplishment of hitherto difficult jobs, are features of the Shaffer Boomer, the manufacturers state. It is sold at all supply stores.

TAG A.S.T.M. Cloud and Pour Test Apparatus

AFTER considerable experimenting, the C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York, has designed a four compartment "cold test" apparatus to meet the latest A.S.TM. cloud and pour test specifications (serial D 97-34) for lubricating oils. These specifications require at least three, and preferably four, cold test baths that must be maintained at the following temperatures:

1—Temperature +30 to +35 deg. fahr.
2—Temperature 0 to + 5 deg. fahr.
3—Temperature —30 to —25 deg. fahr.
4—Temperature —60 to —55 deg. fahr.

The compartments of this newly designed TAG apparatus are copper-lined and well insulated with two in. cork on sides and bottom making them separate cooling units. In each compartment there is an assembly of four metal jackets, mounted on a substantial metal tripod, for supporting the cold test jars and thermometers in accordance with A.S.T.M. specifications. This is the same assembly which has been used satisfactorily for many years in the TAG single unit cloud and pour test apparatus.

The Tagliabue company has prepared bulletin No. 1098 describing this apparatus in detail and giving prices. It will be sent upon request.

Stainless "Clad" Steel Welding Ells

THE Midwest Piping and Supply Company, Inc., St. Louis, Missouri, announces a new development, welding ells made from stainless "clad" steel, which, the manufacturers state, is being enthusiastically received wherever corrosive or erosive fluids must be transported.

The Midwest stainless "clad" steel welding ell is formed from a ply plate having a thin surface of true stainless steel (18-8)

on a foundation of mild steel. The stainless steel is either the lining of the fitting to protect the mild steel covering from the action of the fluid, or it forms the outer covering to protect the inner mild steel from external corrosive conditions. Stainless steel welding rod is used for the longitudinal weld of the stainless surface, and high tensile rod for the carbon steel.

The manufacturers point out that Midwest stainless "clad" steel welding ells have all the advantages of the regular low carbon steel fittings made by the same company: (1) longer tangents (¼ in. per in. of diameter) that facilitate erection and save pipe; (2) unusual dimensional accuracy and uniformity resulting from a special sizing operation; (3) final working of metal in compression (not extruded or stretched) at forging heat that normalizes both the plate and weld; etc.

The company also manufactures stainless "clad" steel pipe.

Additional information regarding Midwest stainless "clad" steel welding ells, or stainless "clad" steel pipe will be furnished by the company upon request.

BRIDGEPORT IS A NATIONAL TUBE DISTRIBUTOR

"Out of Stock" or Mill Shipments

Call us "station to station" at anytime from anywhere.

"You Can Get It from Bridgeport"

We maintain large and well assorted stocks of National Tube Seamless and Lapweld Casing, Drill Pipe, Tubing and Line Pipe throughout Texas, Oklahoma and Kansas.

New yards have been established to promptly take care of emergency requirements in the active fields.

A few joints or full strings of practically any size or weight ready for delivery day or night from yard stocks.

Carload shipments to any destination from Memphis or Mill stocks—intensive tracer service—prompt delivery.

Inquiries solicited from any field, for carloads or less—prices competitive.

Reasonable terms.

Bridgeport Service on National Tube products pleases the discriminating buyer.

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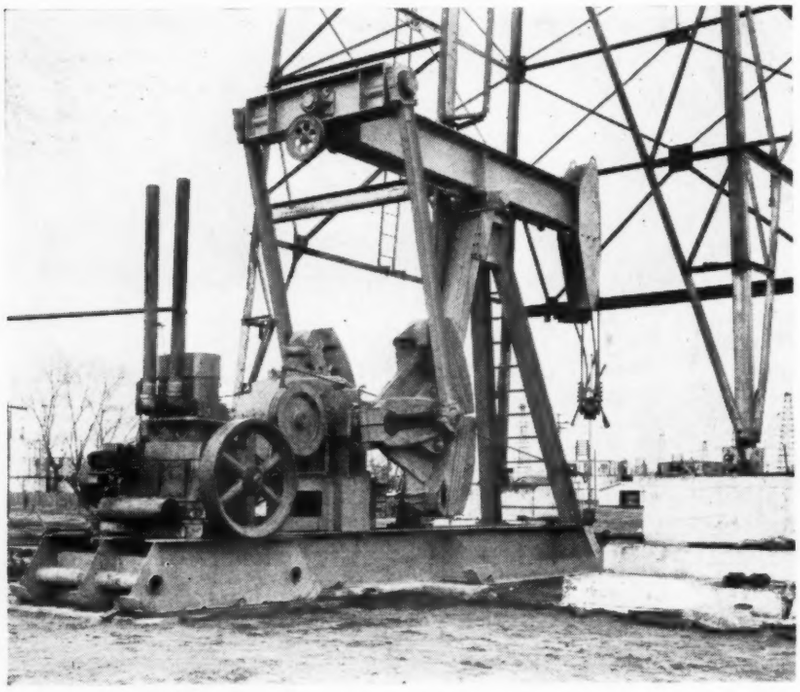
HOUSTON · TULSA · DALLAS · OKLAHOMA CITY · PAMPA · McPHERSON · RUSSELL
AND OTHER ACTIVE MID-CONTINENT AND GULF COAST POINTS

Ideco DT Geared Pumping Units

THE recent announcement of a new series of geared pumping units by The International Derrick and Equipment Company, Columbus, Ohio, has occasioned considerable favorable comment throughout the oil industry. The manufacturer points out to those responsible for keeping production costs down the great overall pumping efficiency of the units and their simplified installation, operation and maintenance on the job.

Engineered throughout from the combined experience of oilfield service and many years of manufacturing oilfield equipment these new Ideco twin-crank, double-reduction, geared pumping units are said to embody every desirable and practical feature known to field and manufacturing practice.



Ideco DT geared pumping unit installation, Oklahoma City field

The unit assembly, with all parts mounted on a rugged, all-welded, steel skid base, saves installation time and assures proper alignment of all parts, the manufacturer states. Careful engineering has so distributed loads and eliminated vibration that there is little need for anchoring the unit in place or the building of any special base. Unit assembly is again an advantage when pumping is abandoned at one well and the pumping equipment transferred to a new location.

Interchangeability of parts is another feature of much value in emergencies. By an elaborate system of jigs, gauges and templets used in the manufacture of parts that enter into the assembly of the units, the company claims to have so perfected the accuracy of its manufacturing methods that similar parts on units of the same size are readily interchangeable in the field.

Mechanical features that production men will appreciate include: Double-reduction gearing for use with either slow- or high-speed prime movers. All gears cut on new Sykes machines. Gear wheels are made of heat-treated cast steel, and pinions are forged integrally with the pinion shafts from heat-treated alloy steel billets. Gears are of the generated continuous tooth herringbone type, lapped in after cutting and before assembling into the units. Gears run in an oil bath and a positive system of lubrication circulates oil continuously through every moving part. All shafts are of generous proportions to minimize deflection under load. Tapered wrist pins fitting into tapered crank hole minimize any tendency of the wrist pin to work loose. The wrist pin operates in SKF spherical roller bearings mounted in a latch-type housing that is sealed against the loss of lubricant and against the entrance of dirt or water yet permits quick and easy removal of the pitman from the wrist pin.

It is interesting to know that the first well ever pumped in the Oklahoma City field was pumped with an Ideco standard steel rig front including Ideco engine and belt house made up of Ideco patented lock joint sheeting. This well is owned by the Continental Oil Company and is on their Sudik lease in the south end of the field. The pumping equipment was installed and the well started to pump about three years ago and is still pumping with no more trouble than the average well in the Seminole field, which was only around 4200 ft. while the Oklahoma City wells are approximately 6500 ft. in depth.

It is also interesting to note that the first well to pump in the Oklahoma City field with the twin-crank, double-reduction, unit is the Continental Oil Company's No. 2 Vineta Park well which started pumping February 15th, 1935, with an Ideco DT-50-S72 twin-crank, double-reduction, geared unit.

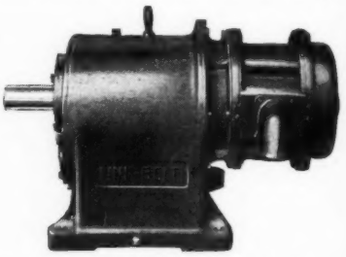
Ideco pumping units in this new "DT" series are available in sizes ranging from 10 to 75 hp. and for use with any type prime mover. The double reduction gearing permits operation with the greatest efficiency and minimum power, whatever the prime mover to be used may be.

Offices and plants of International Derrick and Equipment Company are conveniently located. Offices are at Beaumont, Texas; Columbus, Ohio, and Los Angeles, California; plants at Columbus, Ohio, Delaware, Ohio, Marietta, Ohio, Beaumont, Texas, and Torrance, California; division sales offices are New York, Columbus, Houston, Beaumont Wichita, Los Angeles, Dallas, Tulsa, Kilgore, and Buenos Aires.

Motorized Reducers Announced by Link-Belt

IN order to meet the growing demand for still greater compactness and economy in self-contained enclosed speed-reducing units, Link-Belt Company, Philadelphia, Chicago, San Francisco, announces it is placing on the market a new line of motorized helical-gear reducers, an outstanding feature of which is the unusual accessibility of the motor and the high-speed gears.

A standard round-frame motor conforming with National Electrical Manufacturers' Association specifications, is secured firmly to side of reducer housing by means of an adapter casting which supports the motor shaft in over-size anti-friction bearings close to the pinion, thus assuring good alignment and proper mesh of pinion with its mate. The complete motor, with adapter and motor pinion, may be removed as a unit for inspection or maintenance without disturbing the alignment of the motor, or of the gears remaining in the reducer housing; in fact, the motor pinion and gear are removable without disconnecting the driven machine or disturbing the low-speed gears.

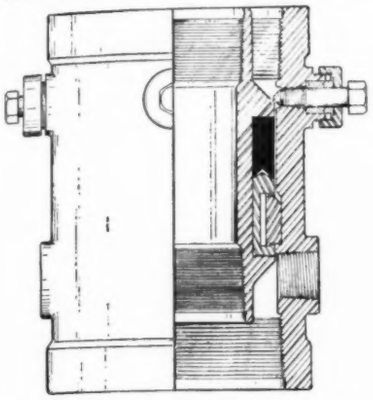


All gears are of the helical type, with teeth cut from heat-treated alloy steel. Anti-friction bearings are used throughout. The low-speed shaft and its bearings are designed to carry overhung loads. A well-braced and ribbed gray iron housing provides a rigid mounting for the bearings, shafts and motor, as well as constituting a liberal-sized reservoir for automatic lubrication of the gears and bearings. Seals are provided at shaft openings to keep the oil in the housing, and the grit and dirt out.

The new motorized reducers may be mounted on floor, ceiling or wall, and are available in double reduction for ½ to 75 hp., in ratios up to 38½ to 1, and in triple reduction up to 30 hp., in ratios up to 292 to 1. They embody the usual advantages of not requiring a motor base plate or a high-speed shaft coupling, and, as the motor forms an integral part of the reducer, the proper alignment of motor shaft is definitely assured at all times, the manufacturers state.

Oil Center Tool Company Announces O-C-T Type "P" Bradenhead

THE Oil Center Tool Company, Houston, Texas, announces O-C-T Type "P" bradenhead, which provides full opening, as the I.D. of the head is the same as the I.D. of the casing on to which it screws.

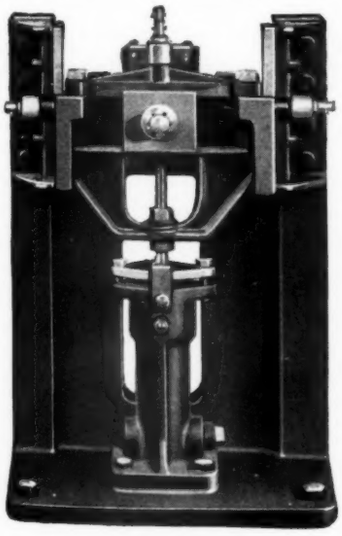


It features also the same size A.P.I. casing thread on top as on bottom, both inside threads.

Type "P" bradenhead is equipped with an expansion hanger collar, allowing it to be run and landed through blowout preventer of same I.D. as that of the casing. When the hanger collar is screwed on the last joint of casing and lowered into suspending position in the bradenhead, packing is expanded by the weight of the pipe. Lock screws further add to compression of packing, while these same screws also hold the hanger collar into position so that the operator does not have to depend solely upon the weight of the casing to hold the string in the hole.

Dearborn Chemical Pump

A NEW chemical pump (pat. appl. for) is announced by the Dearborn Chemical Company. It was developed especially for use in the service of their customers for pumping exact quantities of water-treating chemicals into water supplies at intervals, dependent upon the rate of water flow. However, the pump is adaptable to any type of liquid or semi-liquid chemicals and for close proportioning of coagulants.



The pump presents a combination of improved features in operation, adjustment and design, the result of long study and experimentation by the engineering department of the company in creating "a pump without a weakness," the manufacturers state.

The construction is rugged. Smooth, steady action, without lost motion at all operating speeds, is attained through the centered ball bearings and guided plunger. Stroke adjustment can be set accurately from 0 to 3 inches. The plunger is adjustable for complete cylinder displacement, eliminating air pocketing. All adjustments are made easily with ordinary tools. Plungers are special alloy and all working parts are "nickel semi-steel." The plungers and cylinders are interchangeable from ½ in. to 3 in. diameter. The ½-in. cylinder operates safely up to 1800 lb. pressure, the 1-in. to 1000 pounds.

The pump is lubricated by modern pressure methods, and bearings are of the latest design. The pump is easily demountable and simple to understand. It is designed for extended periods of service without adjustments or replacements.

This new Dearborn pump may be operated by any type of actuating device: water power, electric motor, ratchet or reciprocating motion, chain or belt drive. Height overall is 23½ in.; approximate weight 125 lb. This pump employed in connection with the Dearborn Agitator Type Chemical Vat makes a complete water treating plant unit. Inquiries may be addressed to the company at 310 South Michigan Avenue, Chicago.

REPLACEMENT necessitates a different TYPE

● It is a noteworthy fact as cylinders and rings wear, there is an ever-increasing loss of compression through the enlarged joint openings of ordinary rings as manifested in higher fuel consumption and loss of power. This wear eventually reaches a point where cylinders must be rebored to bring back new engine efficiency.

Even though your engines were delivered with adequate piston rings, some loss already has set in at the time of first ring replacement. To eliminate this waste of fuel, thousands of engineers have turned to COOKTITES as the accepted replacement ring. They have found COOKTITES seal the piston and restore new engine performance even in cases of badly worn cylinders. Whether you operate a gas or Diesel engine—ask us to send you the facts—learn why COOKTITES eliminate compression losses and reduce operating and maintenance costs—write today.

use the accepted COOK'S-GRAPHITIC-IRON PISTON-RINGS for less cylinder wear

C. LEE COOK MANUFACTURING CO.
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LOUISVILLE, KY.
New York Cleveland Los Angeles Baltimore Chicago Tulsa New Orleans San Francisco

Shoot your well with a vacuum!

The CAVINS Automatic Hydraulic Suction Bailer surges the well fluid back and forth through the perforations (or the screen), cleaning them more thoroughly than is possible by any other method. The tremendous hydraulic suction created by The CAVINS recovers the sand from behind the liner, as well as the sand in the perforations and within the liner. Removal of all this sand creates a larger drainage area and permits the well to produce its maximum. Write for illustrated bulletin and other performance data.

It's the Best, Quickest and Easiest Way to Clean Out Your Well

The CAVINS

R. J. Eiche, Foreign Representative, will be in South American oil fields during February, March and April.

THE CAVINS COMPANY

2853 Cherry Ave. Long Beach, Calif., U.S.A.

Cable Address: "Cavins, Long Beach"

R. J. EICHE, *Foreign Representative*

Branches at

Taft, Bakersfield, Goleta and Santa Paula, Calif.

CAVINS CLEAN-CUT SERVICE:

Oklahoma City, Okla., and McPherson, Kans.

CAVINS BAILER SERVICE:

Houston and Kilgore, Texas, and Shreveport, La.

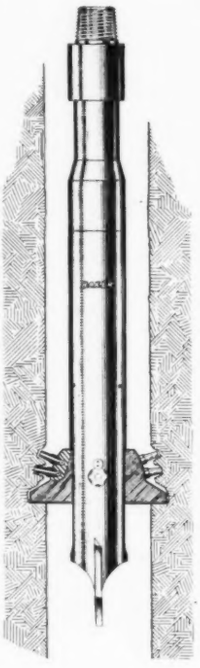
Axelson Perry Plunger

SOLVING the gas problem in the pumping of petroleum represents a forward step in plunger valve design. Many methods to eliminate gas locks in pumps have been tried without complete success. Closer valve spacing allowed much less space for gas accumulation but did not entirely solve the problem because the blind cage, necessarily smaller in diameter than the plunger, created a minor gas-locking condition in itself, reducing the efficiency of the pump.

The new Axelson Perry Plunger eliminates the unwanted gas pocket or trap around the plunger bottom valve, in no way restricting the full passage of fluids, the manufacturers state. The entire valve for the Perry Plunger, including the hardened ball guide, seal and ball and bushing, is completely contained within the plunger. These plungers are furnished in the regular, super-service and chromium-plated types. A new circular on the Perry Plunger (patent pending) has just been issued and may be obtained from the Axelson Manufacturing Company, Los Angeles, California.

Baker Wall Sampler

AN easy, positive method of taking cores from the side-walls of a previously drilled hole is offered with the Baker Rotary Hydraulic Expansion Wall Sampler. It is possible with this new, but field-tested, device to obtain positive information as to formations from which cores were not previously obtained, the manufacturers state. It also will provide a positive method of checking the findings of other correlating methods or devices, it is said.



The Baker Wall Sampler is identical with the well-known Baker Rotary Wall Scraper, except that each blade is provided with two core-taking tubes (as illustrated), thus making it possible to procure four cores at one operation at any depth in the hole.

The blades are opened by pump pressure until the tubes contact the formation, after which the string is lowered slightly, causing the tubes to penetrate the formation. When the string is raised the blades drop downward inside the body.

Baker Wall Sampler Blades are furnished to fit any size Baker Wall Scraper, and take cores from $\frac{7}{16}$ in. to $\frac{11}{16}$ in. in diameter by 1¼ in. to 2½ in. in length in holes from 4¾ in. to 12½ in. in diameter.

Illustrated literature is available by addressing Baker Oil Tools, Inc., Box 609, Huntington Park, California, U. S. A.

Oil-Blast Breakers for Panel Mounting

NEW oil-blast breakers for panel mounting, designated as Type FK-43, have been announced by the General Electric Company, Schenectady, New York. The new type requires 35 per cent less floor space because of the oil-blast principle of interruption, which also increases the reliability of operation, the manufacturers state. Maintenance is reduced materially; silver-to-silver current-carrying contacts prevent cumulative overheating, and a new type of solid butt interrupting contacts will stand thousands of operations, it is stated. Any mounting—such as panels, cubicles, in cells, or on pipe work—can be used; and

the breakers can be operated either manually or electrically. It is universally applicable.

The new FK-43 breakers are rated: 600 amperes, 15,000 volts; 1200 amperes, 7500 volts; with an interrupting rating of 50,000 kva. at the rated voltage.

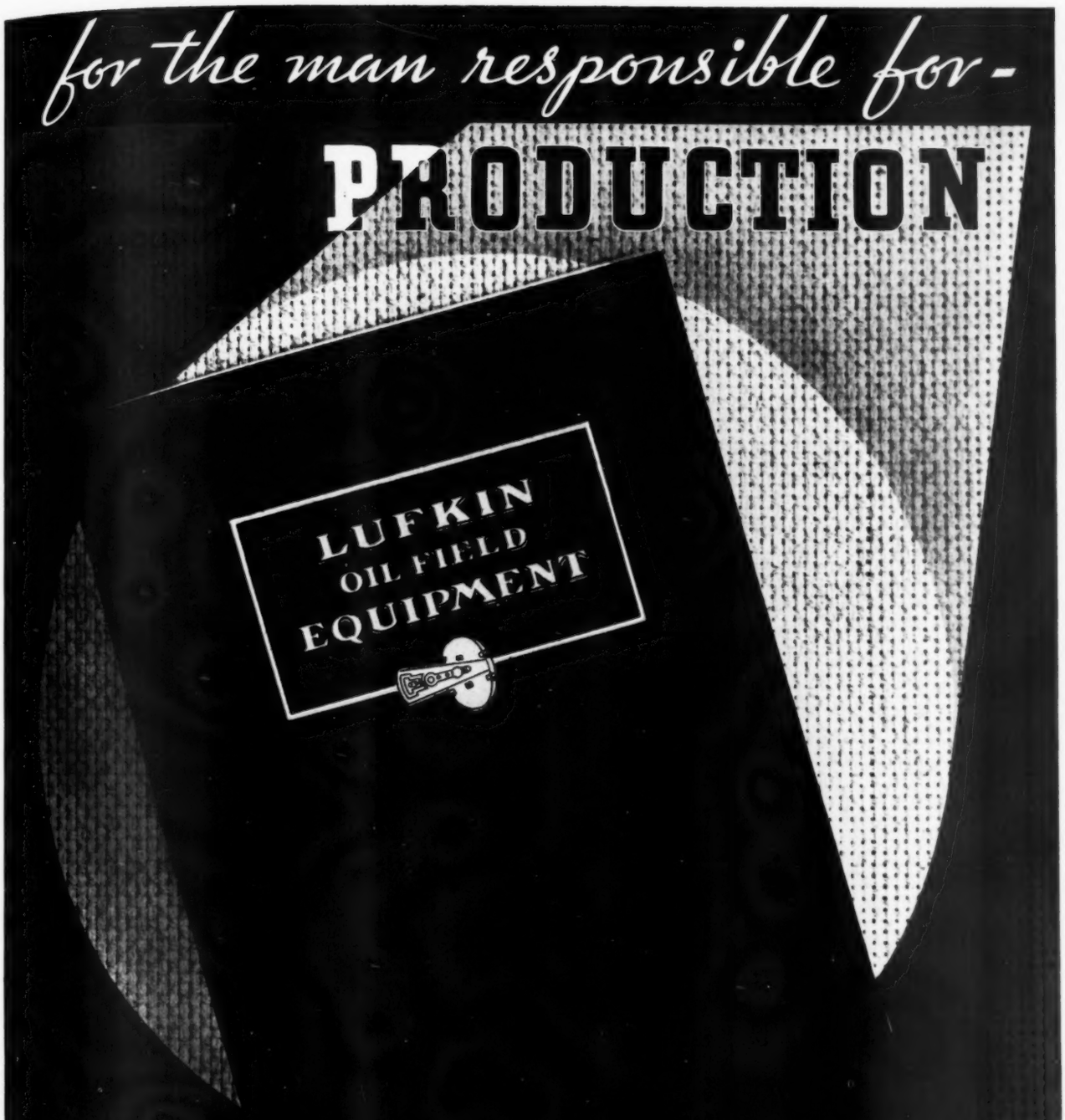
Features of the new breaker are that all three poles are enclosed in one frame and tank, saving time during inspection and giving a compact construction, and that the frame and tank are completely fabricated from steel plate, with all joints welded. The breaker mechanism is of the internal type, giving freedom from pumping and better protection to connected apparatus. Bushings are of Herkolite instead of porcelain. Eight, instead of the usual 13½, gal. of oil are required.

Solenoid-operated breakers are equipped with the trip-free Type MS-5 mechanism, insuring positive tripping when closing on fault currents; and rectifiers and current-trip coils are available for a-c. control. Manually operated breakers are provided with the trip-free HC-2 lever; and remote operation with the operating lever mounted on a panel can be arranged readily.

A complete line of accessories, including tank lifters, over-current trip coils, auxiliary switches, bell alarm switches, mechanical interlocks for panel-mounted manually-operated breakers, undervoltage devices, and self-supporting steel frameworks, are available.

for the man responsible for -

PRODUCTION

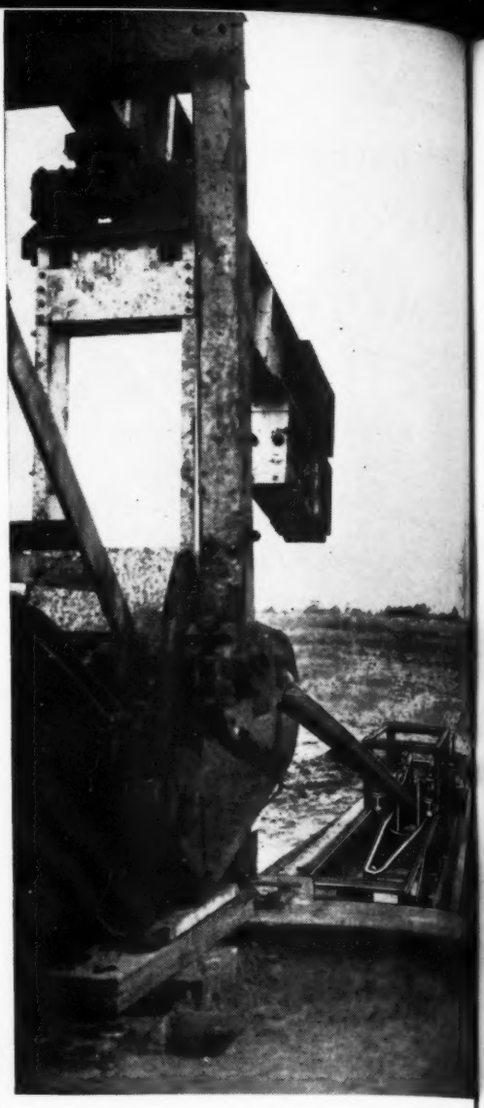


Lufkin's New # 35 *Catalog*

Contains engineering data, dimensions and specifications on all types and sizes of Lufkin Units and other Lufkin Products and mailed free upon request.

LUFKIN FOUNDRY & MACHINE COMPANY . LUFKIN, TEXAS
BRANCHES: HOUSTON, DALLAS, TULSA, HENDERSON, LOS ANGELES, NEW YORK

The Complete Contents of this New Catalog also found in **The Composite Catalog of Oil Field Equipment**



Backside crank hook-up for pumping two wells through a double-end roller hook-off

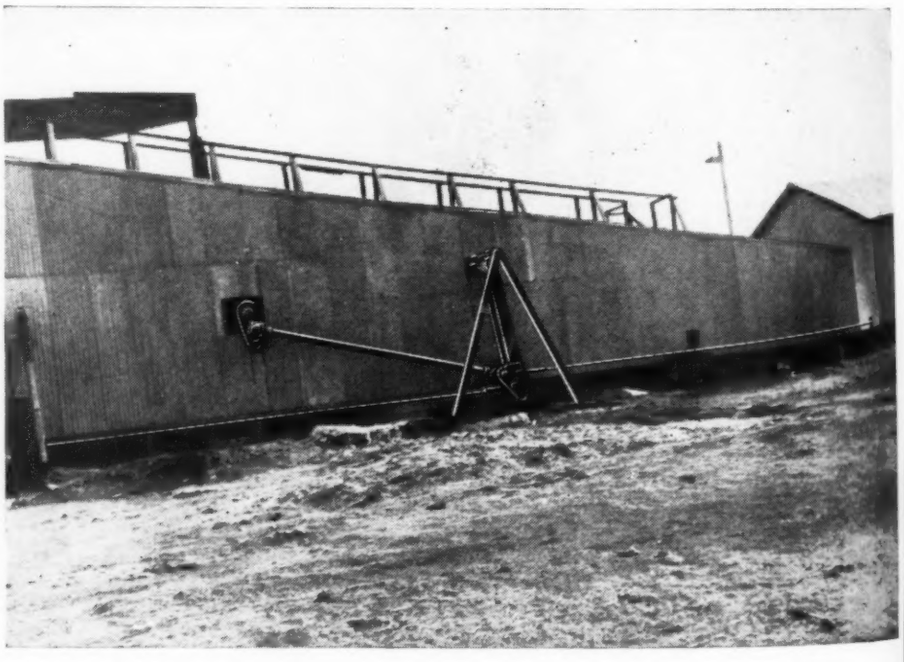
Recent Developments in

Backside Crank Pumping

By H. E. McCRAY
American Manufacturing Company
Fort Worth, Texas

OILFIELD pumping is fundamentally a simple system of bearings and levers. Though never lacking for levers of adequate size, the development of proper bearings with oil reservoirs and dust-proofing has perhaps been slower in the oilfields than in most other large industries. With durable oil-bath bearings on the backside crank wrist-pin and on each end of the pitman, the need arose for changing the stroke in small increments as close to the crank as possible; and with it the present standard type of pipe or structural stroke-post. One disadvantage of this structure was the extreme height of the shackle rod lines, necessitating a catenary curve (or in oil country terms, a "swag in the line") or suitable hold-ups and hold-downs.

Among the first low rod lines to come into general use to the writer's knowledge were those in East Texas in early 1933, at which time the popular take-off to obtain low rod lines was the vertical 180-deg. stroke-post, or so-called "evener" stroke-post, pivoted at the center with an upper bearing connected to the pitman and the lower to one or two rod lines from 8 to 18 in. above the ground. In most of these cases the devastating effect of a reserving load twice that of the shackle rod line was not fully realized, so that within less than 18 months the vertical evener stroke-post began to lose popularity. In its place came the inverted or pendulum stroke-post, in which the regular structural stroke-post was suspended from a suitable frame work, with the pitman working at a down-



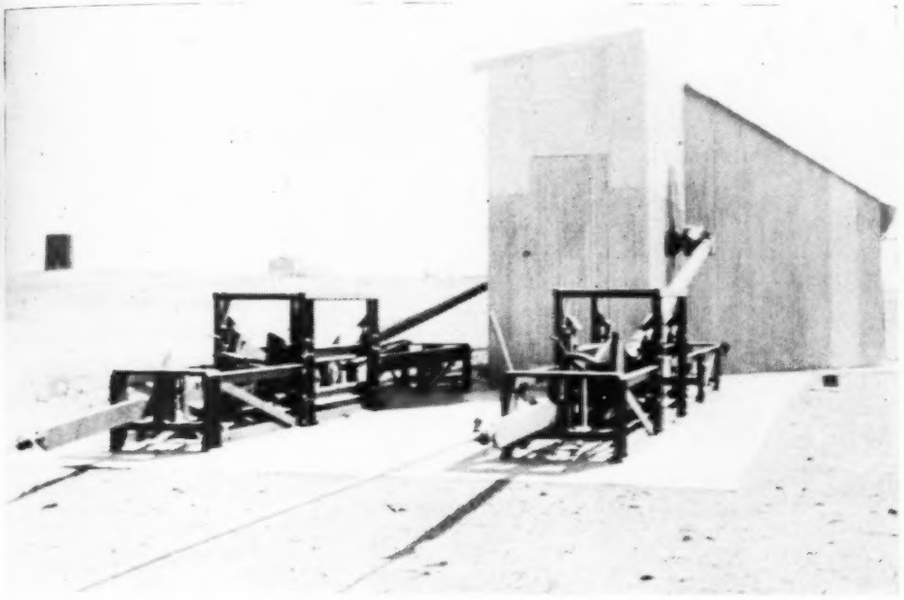
Backside crank hook-up on a beam-pumping well for pumping two extra wells

Backside crank hook-up on a beam-pumping well with short-connected power transmission

ward angle, so that the rod lines are kept at the same low point. To date this seems to be a satisfactory hook-up, as attested by the large number of wells so equipped during the last two years.

Oil company engineers developed more or less revolutionary ideas of their own. Among these was that of obtaining low rod lines and a unit type of installation by using a roller crosshead at the lower end of a long pitman, placing the entire outfit on a light concrete foundation alongside the engine house. This embodied self-contained couplers and hook-off posts, lever-operated and safe, for pumping two or more wells each. Although the earlier installations embodying this idea failed to give due consideration to wear, and, in the interests of safety, were rather complicated, a simpler and more rugged design has been developed.

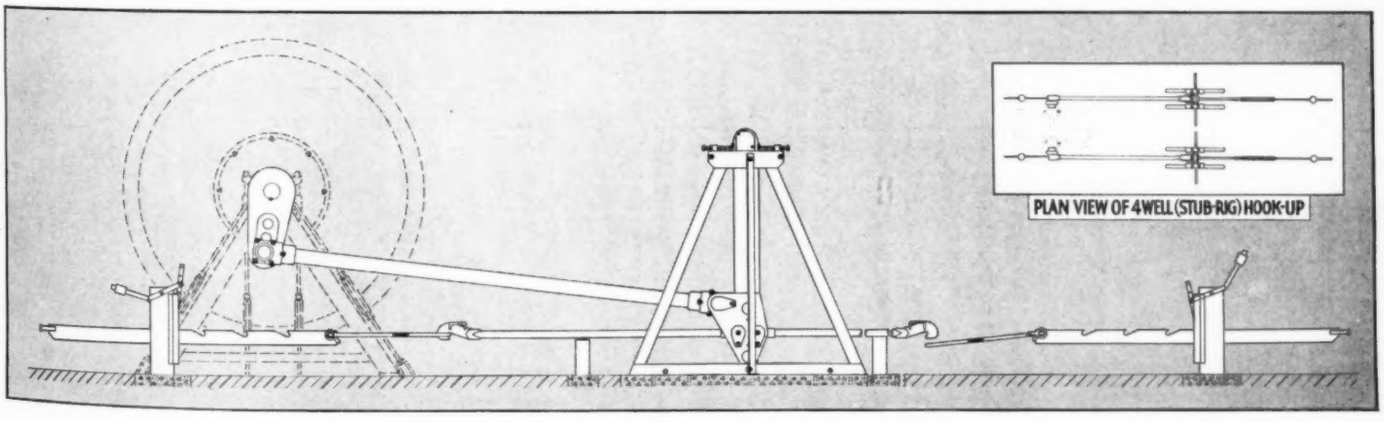
When modern backside crank-pumping equipment first came into use, it was considered a sort of expedient or temporary cost-saving measure. With the vast improvements made in recent years in surface equipment such as hook-offs, shackle rods, hold-ups and hold-downs, swings, and jacks, operators have come to realize that backside crank-pumping equipment, properly installed, is permanent, durable, and economical in operation. This is witnessed by the fact that several major companies in the Seminole and St. Louis fields in Oklahoma, wells in which are notorious for their crooked holes, are pumping three, four, and occasionally more wells, with engines of the same power formerly used on a single beam-pumping well. These installations are necessarily of the permanent type, the foundations and equipment set being of the highest class.



Four-well backside crank-pumping hook-up with two double-end roller hook-offs

An example of this development is that of the major company, whose present designs call for a central power plant, comprising heavy crankshaft, steel band-wheel with double cranks, bronze-bushed jack-post bearings, with cranks attached to two double-end roller type hook-offs, the whole assembly on concrete and entirely inside the engine house. This house encloses the entire mechanism, so that the

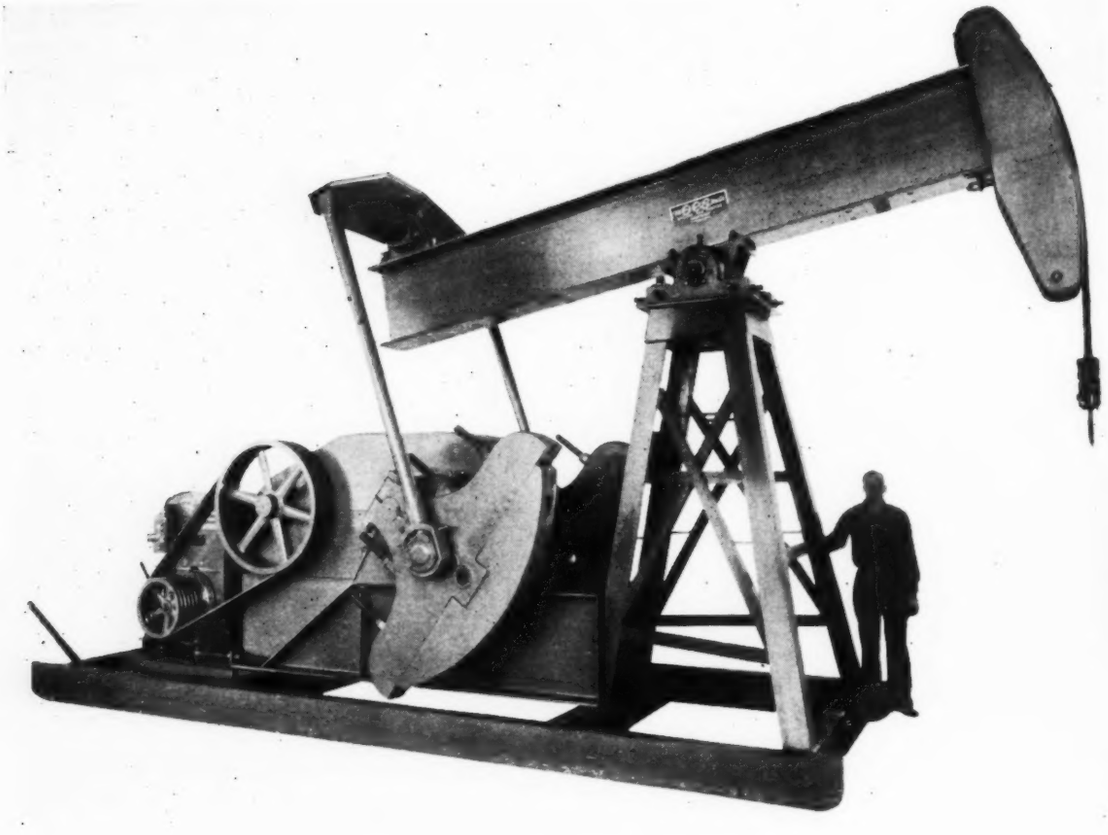
Drawing showing the general arrangement of a four-well (stub-rig) backside crank-pumping hook-up



OCS
Pumping Units

20 H. P.
THE DUCK

40 H. P.
THE GOOSE



THE DUCK *44" Stroke*	*Capacity* *20 Strokes Per Minute* *Pumps*	THE GOOSE *54" Stroke*
3800 ft.	1¾ in.	6600 ft.
3000 ft.	2¼ in.	5000 ft.
2000 ft.	2¾ in.	3500 ft.

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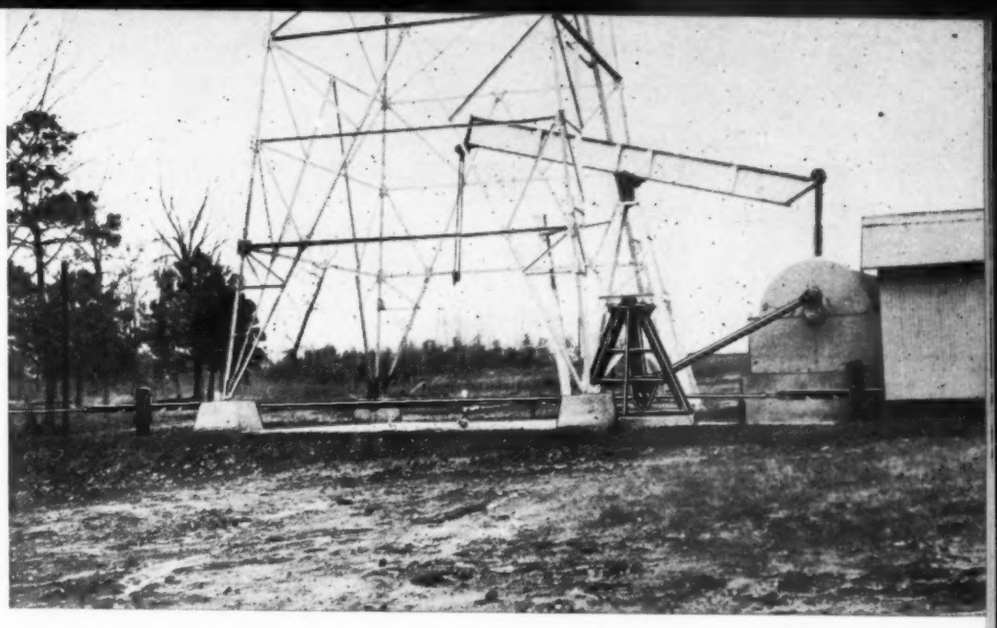


Another type of backside crank-pumping hook-up on a modern equipped pumping well

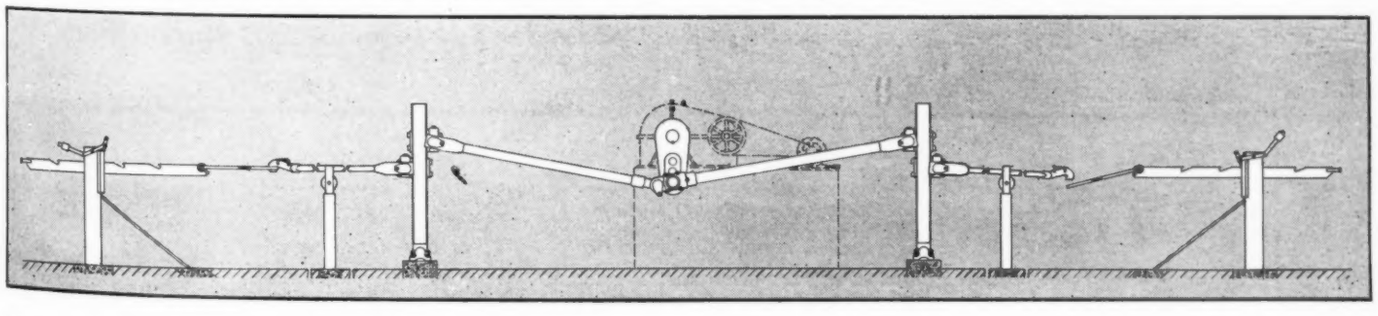
only moving parts outside the power house are the shackle rods, swings, etc., going to the various wells. A hook-up of this type has a low initial cost and is successfully used on from two to eight wells on each "stub-rig," depending, of course, upon the depth and dynamometer characteristics of the wells.

It has occasioned surprise among many operators seeing one of these installations for the first time to observe that a beam-pumping engine (ordinarily well loaded during the pumping stroke) handles three or four wells with apparently as much ease and less change of speed than the same engine pumping one well. An occasional complaint heard among field men where the wells are not properly attached, is that one certain well pumps harder than the other two or three together. One such instance was observed recently where the front crank was attached to the beam (not counterbalanced) with the backside crank at 90 deg. instead of 180 degrees. The outfit ran satisfactorily until the "pull" well (the well farthest from the crank) was hooked-off, at which time the engine labored appreciably and the belt had to be drawn up tightly to pull the load without slipping and squeaking. In this instance it was found that in installation, one of the backside wells lifted simultaneously with the beam, resulting in two wells lifting together, instead of one. Proper care in installation and the survey of the pumping time of the various wells will readily show the best way to couple the wells, and proper instructions to the pumper on pumping times and hooking-on and hooking-off sequence readily prevents such difficulty.

A backside crank-pumping hook-up for four or more wells. Note the substantial concrete foundations

Because of the flexibility in power requirements and initial cost it provides, such an installation seems to offer an attractive middle ground between the individual geared pumping unit or standard rig on each well, and the more elaborate installation of the central geared or bandwheel power. A first-class installation of an excellent plant of this type in a four-well hook-up usually costs about $1200 per well, and in some cases much lower. This includes the installation of heavy jacks set on concrete, with the shackle rod equipment as heavy as the need requires. There is no question of the dependability of the standard rig or geared pumping unit nor of the low lifting costs of a central power or central electric plant, but backside crank-pumping equipment of good design properly installed certainly fills a need somewhere between these two and provides an increased flexibility in hook-up to fit the changing power requirements of the wells.

Drawing showing crank wrist-pin connections and hook-off equipment for two or more wells



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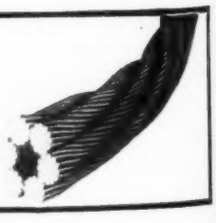

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
● K. C. SCLATER ●
Editors

Elements of Applied Petroleum Production

Article 18

CENTRAL PUMPING POWERS

(Continued)

By K. C. SCLATER

LAST MONTH bandwheel powers in general were discussed. Some of the important points to observe in balancing a bandwheel power were also outlined.

Well loads can now be measured with much greater accuracy than was possible a few years ago. Dynamometers are now in general field use for this purpose.

One of the important considerations brought out by Nowels[75] is that not only should care be taken to see that the pumping load is divided equally between the eccentrics but also to see that the load on each eccentric is uniformly distributed around the eccentric circumference.

GEARED POWERS

Geared pumping powers with the gears entirely enclosed and running in oil are a comparatively recent development.

Although the first of these, which was of the worm-gear type, came out about 1925, it is only within the last three years or so that the other geared powers of the totally-enclosed type now in use were introduced. This development is indicative of the trend toward greater refinement in engineering design and the desire for higher efficiency in pumping operations.

All modern geared powers are of the overpull type, with single or double eccentrics, disks, or cranks. The gears are driven from the engine through a driveshaft.

One such power, for example, designed for moderately high pumping speeds has a 100-hp. rating. It is of the double-crank overpull type, the lower crank having a 36-in. throw and positions for 12 wells, and the upper crank a 30-in. throw and positions for eight wells. Power from the engine to the driveshaft is transmitted by V-belt, and the driveshaft, which extends from the engine to the power, is $3\frac{5}{16}$ in. in diameter and 30 ft. long. By using a driveshaft of this length, the "blind angle" of the power is kept small. This is very desirable, for it usually is a great help in balancing the power. It perhaps should be explained here that the blind angle is the angle extending from the center of the power within which the engine, transmission, or other part of the power proper lies so as to be an obstruction in the path of shackle lines. It is for this reason that in designing and laying out a central pumping power care should be taken to have as small a blind angle as possible; either that, or the power should be so located that the blind angle will not interfere too much with the proper balancing of the power.

Another such power, rated at 80 hp. at a speed of 20 strokes per minute, has 36-in. double eccentrics and is of the overpull type. Power is transmitted from the engine power take-off to the driveshaft by V-belt. The driveshaft is $3\frac{7}{16}$ in. in diameter and 20 ft. long and is mounted in three self-aligning roller bearings of the dust-proof, abrasive type. A 12-groove pulley of 24-in. diameter is mounted on the driveshaft and a pulley of 11.8-in. diameter on the engine. The power has a total reduction of 27.7 to 1.

Another geared power in use has a single-crank with a 36-in. stroke and is driven through a driveshaft that is 40 ft. long. The driveshaft runs in self-aligning roller-bearing pillow blocks with adjustable sole plates. A V-belt transmits power from the engine to the driveshaft.

Besides the worm-gear type of central pumping power there are four others, all having a double reduction. One of these has a train of spiral bevel gears for the first reduction and a train of double-helical, or herringbone, gears for the second reduction. The three others have a train of spiral bevel gears for the first reduction and a train of single-helical gears for the second reduction.

In the geared power just mentioned with the 27.7 to 1 reduction, for example, the high-speed pinion is 14-tooth, $2\frac{1}{2}$-diametral pitch, 4-in. face, spiral bevel, of heat-treated chrome-nickel steel, integral with the shaft; and in intermediate gears are: a spiral bevel gear of 64-tooth, $2\frac{1}{2}$-diametral pitch, 4-in. face, of double heat-treated cast steel; and a single helical pinion, 18-tooth, 2-diametral pitch, $6\frac{1}{4}$-in. face, of heat-treated forged steel. The low-speed gear is 109-tooth, 2-diametral pitch, 6-in. face, with double heat-treated forged steel rim, shrunk on to a cast-iron hub and keyed in place. The intermediate shaft is $4\frac{1}{4}$ in. in diameter by 8 in. long; and the high-speed shaft is 4 in. in diameter and of heat-treated chrome-nickel steel. On this geared power the maximum safe well loads that may be attached to the power and concentrated at one point on either eccentric are:

On 24-in. eccentric - - -	17,800 lb.
On 30-in. eccentric - - -	14,300 lb.
On 36-in. eccentric - - -	11,800 lb.

Based on a combined overall efficiency from power to pump

of 60 per cent, the b.hp. input varies from 40 b.hp. at ten r.p.m. to 95 b.hp. at slightly more than 23½ r.p.m.

The greater refinements in measuring well loads, in counterbalancing wells, and in the installation of shackle lines and surface equipment make it possible to balance the load on a geared power for maximum operating efficiency. The fact that great progress has been made in these directions has hastened the use of the geared types of power. Other considerations that have favored their adoption in the oilfields are: being totally enclosed they require no housing and their operation is not impaired by changing weather conditions; the gears always working in a bath of oil and having ample lubrication permit the power to be operated continuously over long periods with the minimum of attention.

As many as 42 wells have been pumped from one geared central pumping power. One such power,[76] immediately after installation about 2½ years ago, was operating this number of wells, only 21 of which were connected directly to the power. Each of the 21 shackle lines from the power was equipped at some convenient point with a multiple swing, from which two rod lines were led off to separate wells. Thus each shackle line connected directly to the power was used to pump two wells. The wells were producing from a sand at a depth of 1200 feet. The power was equipped with a special crank that had a 10-in. throw (20-in. stroke), and the prime mover was a gas engine with a 65-hp. rating.

In the preliminary discussion of central pumping powers last month it was pointed out that "a central power consists essentially of a prime mover and some type of power transmission." In the bandwheel type of central pumping power, belts are used to transmit power from the prime mover to the shackle lines.

In the geared type of central pumping power, gears are the principal medium used to transmit power from the prime mover to the shackle lines. The train of gears totally enclosed in the cast-iron case is essentially a power transmission system. As such, the modern geared power is well adapted to the use of high-speed prime movers because a large reduction in speed between the power input end and the power output end of the train of gears can be obtained in an efficient and compact manner.

The designing of gears for power transmission is a highly specialized field of engineering and the matter of rating gears, particularly those for oilfield service, is quite involved. (See references 77, 78, 79, 80, and 81 at the end of this article discussing the rating of gear units for oil-well pumping). In view of this fact it is desirable, therefore, to have reliable information regarding the load-carrying capacity of a geared power. If the manufacturer's method of rating is thoroughly understood, the load-carrying capacity of a geared power can be determined with sufficient accuracy for practical field needs.

A geared power is balanced in essentially the same manner as other types of central pumping powers. The working load and pumping characteristics of each well should be ascertained by tests with a dynamometer.

GENERAL LAYOUT. The logical site for a central pumping power is the geographical center of the group of wells to be pumped. Local conditions will usually enter to modify such a choice. Since economical operation is the chief consideration to be kept in view, efforts should be made to choose a location that will result in all wells being connected to the power in the most direct manner possible. This means that the shackle or rod lines should have a minimum number of swings, hold-ups, hold-downs, and the like.

In level country where there are few natural obstacles such as streams, open bodies of water, or big trees, or few artificial obstacles such as roads, lease buildings or the like, the layout of the power so far as these items are concerned may offer no special difficulties. Other considerations, however, usually will enter.

Natural obstacles such as rugged topography, streams, open bodies of water, or big trees may enter as important governing factors in choosing the location for a central power.

Aside from natural and artificial obstacles there are other vital factors in connection with the power layout that are more uncertain, and hence more difficult, upon which to estimate changing power requirements at the wells. Among these are water encroachment, declining production, or paraffin trouble; the possible addition of wells now flowing or wells to be drilled at a later date; and proration regulations. The last-named has become important in recent years in those fields where the wells are capable of a much greater rate of production than wells of the stripper class.

It is good practice to survey the topography of the area embraced by the group of wells to be pumped and prepare a map. The map should have 5-ft. or 10-ft. contours and should show the wells and all the natural and artificial features that will affect the layout of the power and the shackle-line equipment.

With this information the power and the shackle lines can be laid out on paper. From the well-load data, force diagrams may be plotted and the power balanced on paper. Thorough preliminary work of this kind will be repaid in the possible operating economies that will result. This is obvious when it is considered that a central power usually has to operate 24 hours a day, week after week and month after month over a period of years. Power savings, reduced wear and tear on equipment, and low maintenance expense will mean low lifting costs over the period of years that the central power is in operation.

●

QUESTIONS

1. What is meant by the "blind angle" when referring to a central pump-power?
2. In what important respects does a geared power differ from a band-wheel power?
3. Name some of the important factors that are likely to govern the location of a site and the general layout of a central pumping power.

●

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A New Type of Crude Oil

THE importance of Texas to the oil industry is well known and often referred to by petroleum technologists throughout the world. Ranking first among the oil-producing states, the number of wells drilled within its borders in 1934 represented 56 per cent of the total for the nation, as a whole.

What is not so generally known, however, is the fact that almost all conceivable varieties of crudes are now produced in commercial quantities from the various Texas fields. These range from the highly paraffinic Ranger crude (which some have asserted comes from the same geological formations characterizing the oil fields of Pennsylvania and West Virginia) through the mixed bases of North and East Texas, the asphaltic and naphthenic of the Gulf Coast to—finally and most recently—the highly aromatic crudes of the South Texas fields.

These last-mentioned are well illustrated by the crude oil coming from a field less than one year old and which is only a few miles from the Rio Grande River, the border line between Texas and Mexico. This is the Sam Fordyce field in Hidalgo County, with a present potential production in excess of 15,000 bbl. daily.

A typical, fairly complete analysis and a significant summary of conclusions concerning the Sam Fordyce crude are as follows:

Gravity of crude	21.4 deg. A.P.I.
Color of crude	Green
Odor of crude	Aromatic
B. S. & W.	0.5 per cent

100 cc. Engler Distillation of Crude

Initial Boiling Point	440 deg. fahr.
10 per cent	482 deg. fahr.
16 per cent	500 deg. fahr.
20 per cent	510 deg. fahr.
30 per cent	534 deg. fahr.
40 per cent	558 deg. fahr.
50 per cent	590 deg. fahr.
54 per cent	600 deg. fahr.
Gr. of total distillate(54 per cent of crude)	27.1 deg. A.P.I.
Color of total distillate	Light yellow
Cold test of total distillate	Below 0 deg. fahr.
Doctor test of first 10 per cent of distillate	Sweet
Color of residue	Green
Cold test of residue	10 deg. fahr.

Second Distillation of Crude:

Two thousand two hundred cc. were charged into a glass flask and distilled with fire heat and steam under atmospheric conditions. The last ten per cent overhead cut was distilled separately in the same manner for a light lubricating oil cut of 90 viscosity at 100 deg. fahrenheit.

The total distillate was placed in a balloon type glass flask and distilled as above, but with use of the standard Hempel column. The first two per cent cut had a gravity test of 33.1. The next 7.3 per cent was added to this one, yielding 9.3 per cent (of the crude) of a product of the following characteristics:

Gravity	31.1 deg. A.P.I.
Color	17 Saybolt
Closed cup flash test	108 deg. fahr.
Cold test	Below 0 deg. fahr.
Doctor test	Sweet

Ten Per Cent Engler Distillation:

Initial Boiling Point	368 deg. fahr.
10 per cent	385 deg. fahr.
20 per cent	402 deg. fahr.
30 per cent	416 deg. fahr.
40 per cent	430 deg. fahr.
50 per cent	442 deg. fahr.
60 per cent	436 deg. fahr.
70 per cent	470 deg. fahr.
80 per cent	488 deg. fahr.
90 per cent	544 deg. fahr.
End Point	570 deg. fahr.

The second fraction, 53.4 per cent of the crude, had the following tests:

Gr.	25.2 deg. A.P.I.
Flash test	225 deg. fahr.
Fire test	250 deg. fahr.
Cold test	Below 0 deg. fahr.
Color	Straw

The total residue, 36.3 per cent of the crude, tested as follows:

Gr.	14.5
Flash test	380 deg. fahr.
Fire test	445 deg. fahr.
Viscosity at 210 deg. fahr.	98
Viscosity at 100 deg. fahr.	3,600
Cold test	10 deg. fahr.
Color (⅛ in dil.)	Dark green
Carbon residue	2.94 per cent
Viscosity Index	Minus 70

SUMMARY

First cut	9.3 per cent
Second cut	53.4 per cent
Residue	36.3 per cent
Distillation loss	1.0 per cent
Total	100.0 per cent

CONCLUSIONS

1. The crude contains no gasoline fractions and no kerosene fractions.

2. The 9.3 per cent cut, though of furnace-oil-like characteristics, might prove difficult to sell as such because of its extremely low gravity test of only 31.1. Usually, furnace oils are of 36 minimum gravity.

3. The second cut of 53.4 per cent plus the above cut; i. e., a total of 62.7 per cent of the crude, would be marketable as zero cold test gas oil.

4. The residue of 36.3 per cent could be treated by chemical means to produce a fair grade of heavy lubricating oil of green color, but on account of the extremely low viscosity index it would have, it would have to be sold at a cheap price. The carbon residue (2.94 per cent) is less than that of a similar cut from Ranger crude, indicating less refining expense.

5. From the doctor tests it is evident the crude contains only a small amount of sulphur, doubtless not over one per cent.

6. The crude has practically no asphalt in it.

7. From the odor and gravity tests of all products it is evident that the crude has in it:

(a) Practically no paraffinic constituents; hence, even by the new solvent-treating methods it is improbable that it could be made to yield high grade lubricating oils; that is to say, oils of Pennsylvania-like or Mid-Continent-like characteristics.

(b) The hydrocarbons present belong chiefly to the aromatic series. The amounts of paraffin, asphalt and naphthenic series must be quite small indeed.

(c) There are significant possibilities to produce from the crude many valuable aromatic chemical compounds.

(d) In the above respects, the crude is quite different from most others in other American oil fields. It apparently closely resembles certain East Indies crudes.

(e) By cracking to coke or to a low percentage liquid residue the crude would yield approximately as follows:

Very high Anti-knock gasoline-like fractions	75 to 80 per cent
Gas	15 to 10 per cent
Coke, or heavy gravity fuel oil	10 to 10 per cent
Total	100 to 100 per cent

The 75 to 80 per cent gasoline yield would require addition of a considerable amount of natural gasoline (10 to 20 per cent) to increase the gravity and balance out the distillation curve, in order to produce salable product as finished gasoline. This product, i.e., 75 to 80 per cent, of the crude, would, however, be salable to refiners and wholesale marketers as a highly desirable material for blending, giving a premium gasoline. In either case it would produce an anti-knock gasoline of at least 75 octane number, thus giving, without use of anti-detonating chemicals, a premium-priced gasoline.

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Elements of Applied Petroleum Pipe Line Transportation

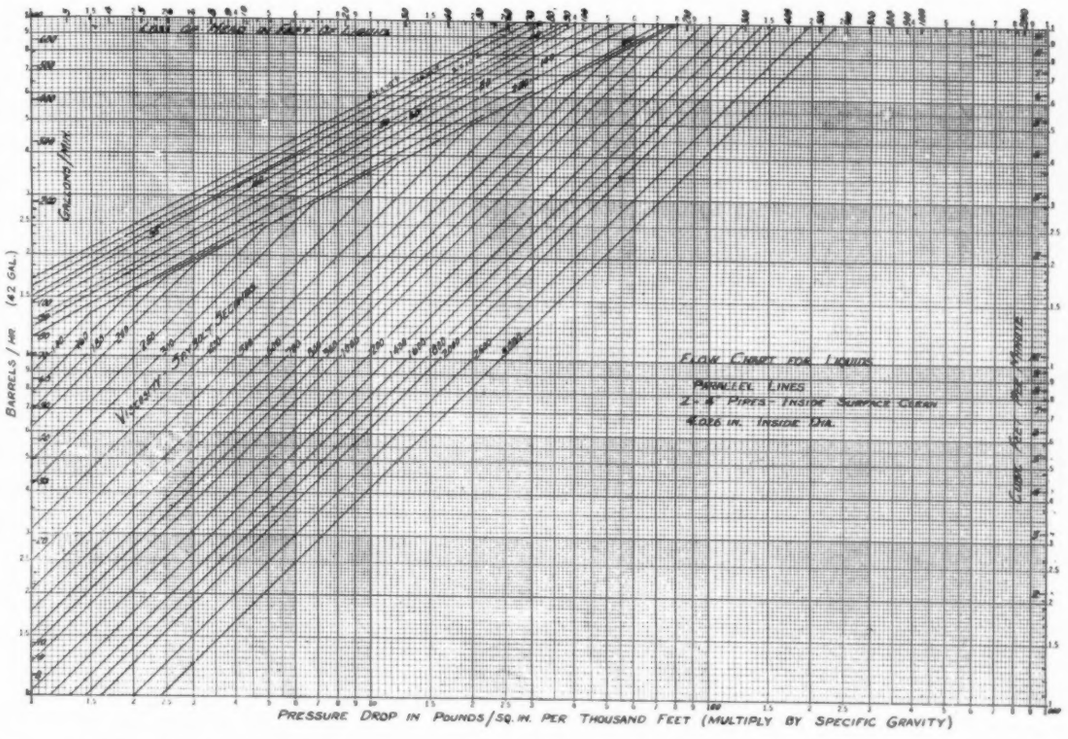
Article 8

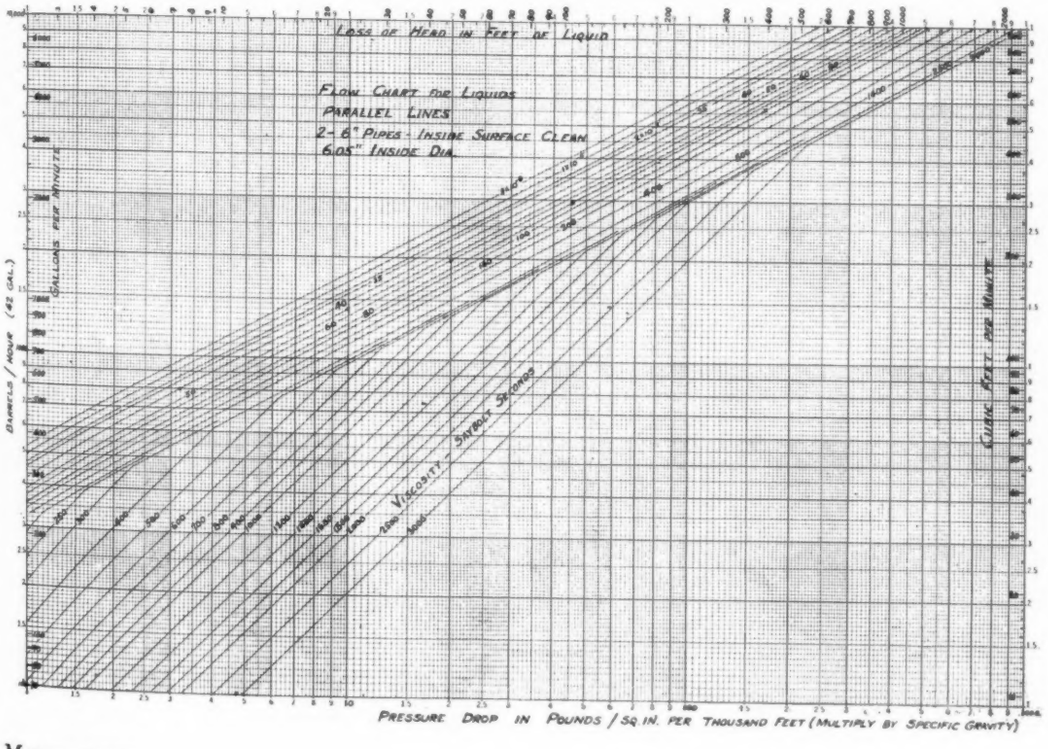
THE FLOW OF OIL IN PIPES AND PIPE LINES

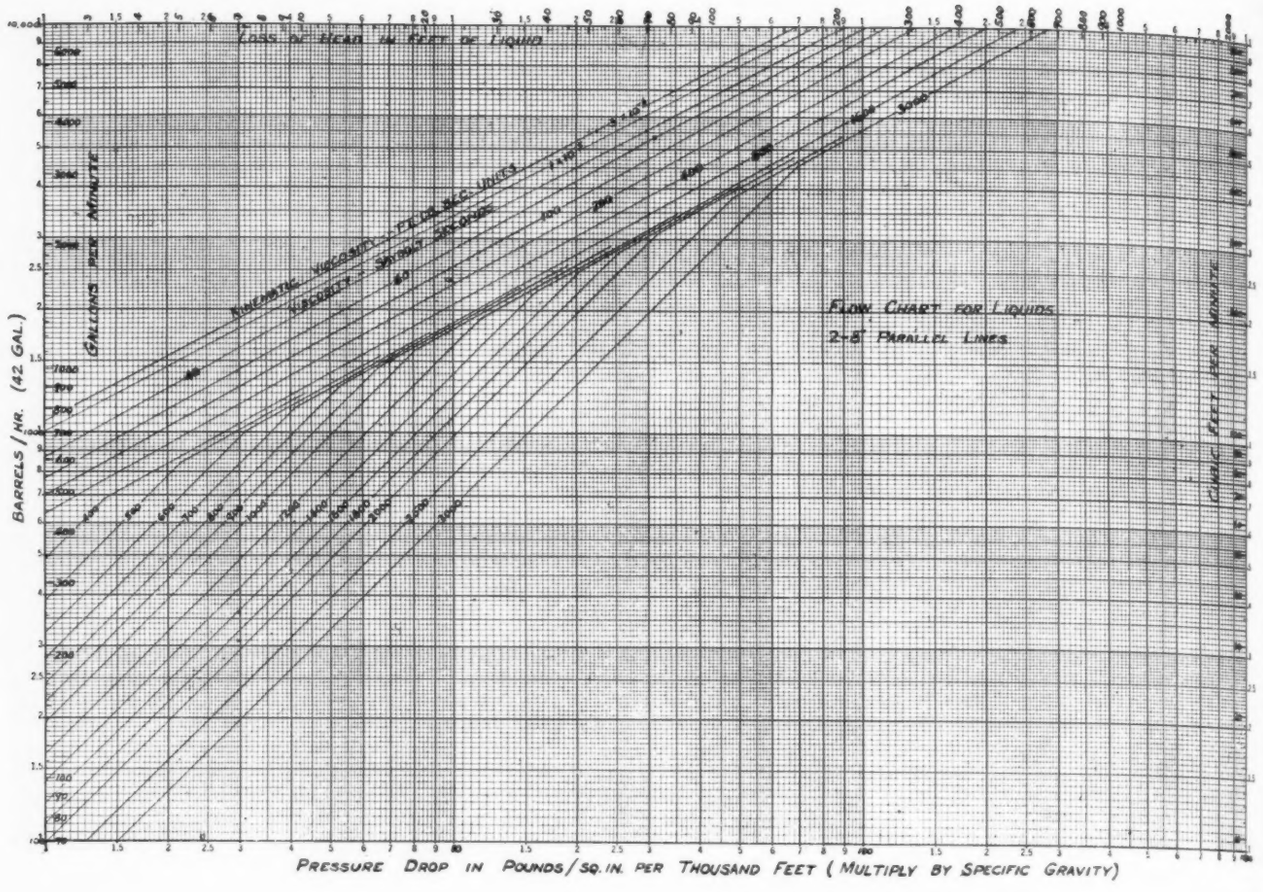
By EMORY KEMLER
and L. L. THOMAS

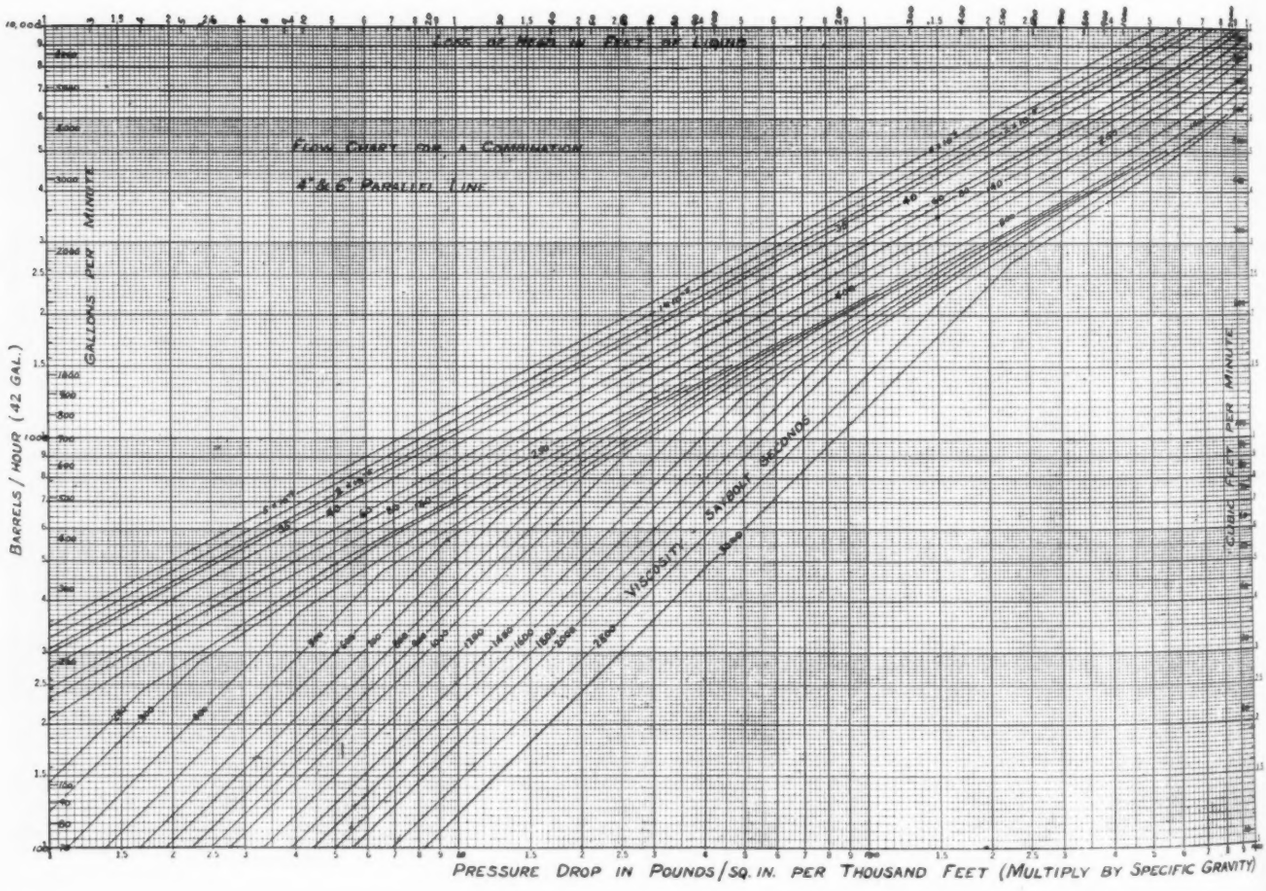
Flow Charts

FOUR charts are given this month for the solution of flow problems in pipes and pipe lines, namely: two parallel 4-in. pipes, two parallel 6-in. pipes, two parallel 8-in. pipes; and combination 4-in. and 6-in. parallel pipes.


Loss of Head in Feet of Liquid
Gallons/Min.
Barrels/Hr (42 Gal.)
Viscosity - Saybolt Seconds
Flow Chart for Liquids
Parallel Lines
2-4" Pipes - Inside Surface Clean
4.026 in. Inside Dia.
Cubic Feet per Minute
Pressure Drop in Pounds/Sq. In. per Thousand Feet (Multiply by Specific Gravity)


Loss of Head in Feet of Liquid
Flow Chart for Liquids
Parallel Lines
2-6" Pipes - Inside Surface Clean
6.05" Inside Dia.
Gallons per Minute
Barrels / Hour (42 Gal.)
Viscosity - Saybolt Seconds
Cubic Feet per Minute
Pressure Drop in Pounds / Sq. In. per Thousand Feet (Multiply by Specific Gravity)


LOSS OF HEAD IN FEET OF LIQUID
BARRELS / HR. (42 GAL.)
GALLONS PER MINUTE
CUBIC FEET PER MINUTE
KINEMATIC VISCOSITY - CENTISTOKES
VISCOSITY - SAYBOLT SECONDS
FLOW CHART FOR LIQUIDS
2-6" PARALLEL LINES
PRESSURE DROP IN POUNDS/SQ. IN. PER THOUSAND FEET (MULTIPLY BY SPECIFIC GRAVITY)


LOSS OF HEAD IN FEET OF LIQUID
FLOW CHART FOR A COMBINATION
4" & 6" PARALLEL LINE
BARRELS / HOUR (42 GAL.)
GALLONS PER MINUTE
CUBIC FEET PER MINUTE
VISCOSITY - SAYBOLT SECONDS
PRESSURE DROP IN POUNDS/SQ. IN. PER THOUSAND FEET (MULTIPLY BY SPECIFIC GRAVITY)

Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XVII

HEATING AND HEAT LOSSES

IN general, there are three ways by which heat may be transferred from one material to another. These are conduction, convection, and radiation. In some cases, the transfer of heat occurs almost entirely by one of the three above-mentioned methods, but usually a combination of two of them, or even all three of them, occurs at the same time.

CONDUCTION

An example of nearly pure conduction is the flow of heat through a furnace wall or an insulated pipe. In both of these cases the amount of heat that is lost is kept low by insulating the hot surface or material with a material whose conductivity is low. The conductivity of a material is a measure of the ability of that material to conduct heat. In English units, the conductivity is the number of British Thermal Units (B.t.u.) that will be conducted in one hour through a surface having a cross section of one square foot and a thickness of one foot when the difference in temperature is one degree fahrenheit. Thus, the factors that govern the flow of heat are the cross-sectional area, the thickness, the temperature difference, and the conductivity of the material.

$$Q = \frac{K\,A\,(T_2 - T_1)}{L}$$

in which:

Q = B.t.u. heat transferred per hour.
A = Area of cross section in sq. ft.
T_2 and T_1 = Temperatures at hot and cold surfaces, respectively.
L = Thickness in feet.
K = Conductivity in B.t.u. for one ft. of thickness per sq. ft. per hour per deg. fahr. temperature difference.

The conductivity is a function of temperature but it varies only slightly unless the temperature range is great. Table 21 shows commonly accepted conductivity constants for several materials.

In using the above equation it is convenient to use Isaac Newton's conception of driving forces and resistances. In the above equation the driving force is the temperature difference and the other factors are the resistance to the flow of heat.

$$Q = \frac{\Delta T}{L/KA} = \frac{\Delta T}{R}$$

When several materials compose the wall through which heat is being transferred, the amount of heat that is conducted through each material is a constant amount, but the temperature difference across each material is of different magnitude. Thus, the flow of heat through a series of resistances may be described as follows:

$$Q = \frac{\Delta T}{\frac{L_1}{K_1A_1} + \frac{L_2}{K_2A_2} + \frac{L_3}{K_3A_3}} \text{ or } \frac{\Delta T}{R_1 + R_2 + R_3}$$

EXAMPLE 26. *Heat Loss Through Furnace Wall*

A furnace wall consists of nine in. of firebrick, 4½ in. of sil-o-cel brick, four in. of red brick, and ¼ in. of cement board. The inside wall of the furnace is at 1800 deg. fahr. and the outside at 200 deg. fahrenheit.

How much heat is lost per hour through a wall having 10 sq. ft. of cross section area? Refer to Fig. 38.

Basis: 1 sq. ft. of wall area.

The cross section area will be the same through all the materials.

$$Q = \frac{\Delta T}{\frac{L_1}{K_1} + \frac{L_2}{K_2} + \frac{L_3}{K_3} + \frac{L_4}{K_4}} = \frac{1800 - 200}{\frac{9}{12 \times .82} + \frac{4.5}{12 \times .125} + \frac{4}{12 \times .52} + \frac{.25}{12 \times .23}}$$

$$Q = \frac{1600}{.915 + 3.0 + .641 + .0905} = 344 \text{ B.t.u. per sq. ft. per hour.}$$

Through 10 sq. ft. the loss is 3440 B.t.u. per hour.

In the case of pipe insulation the computations are complicated somewhat by the fact that the area through which heat is transferred is greater at the outside of the insulation than at the inside of the pipe. If the thickness of the material is small, compared to the diameter, the arithmetic average of the two areas may be used. If, however, the thickness is great, then the logarithmic mean area, as given below, must be used.

$$\text{Logarithmic Mean Area} = \frac{A_2 \text{ (large area)} - A_1 \text{ (small area)}}{2.3 \log \frac{A_2}{A_1}}$$

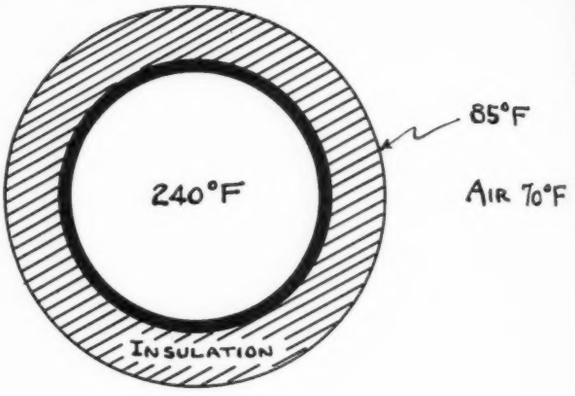
TABLE 21

Conductivity—B.t.u. for a foot thickness per sq. ft. per hour per deg. fahr. temperature difference

Material	Temperature	Conductivity
Brass (70-30)	212	72.5
Iron (wrought)	212	35.
Iron (cast)	70	22-36
Steel (0.1% carbon)	212	25.
Firebrick	1800	0.82
Sil-o-cel brick		0.125
Common or Red Brick	500	0.52
Brick and Mortar Wall	70	0.4
Cement and asbestos board	212	0.23
Magnesia insulation	212	0.04
Cork	212	0.03

*Professor of Petroleum Refining, University of Tulsa.

Fig. 39. Heat loss through insulated pipe



The arithmetic mean area may be used for all cylindrical vessels with normal insulation and for pipe sizes, with standard insulation, down to two inches. For a 2-in. pipe with standard insulation, the error by using arithmetic area is only four per cent. For smaller sizes the logarithmic mean area should be used.

EXAMPLE 27. *Heat Loss Through Pipe Insulation*

A standard 6-in. pipe is insulated with high temperature insulation (k = .04) that is 2½ in. thick. The pipe carries steam at 240 deg. fahr. and the outside of the insulation is at 85 deg. fahrenheit. The resistance of the pipe wall is negligible. (See Fig. 39).

What is the heat loss from 1000 ft. of pipe?

Basis: 1 foot length of pipe.

$$\text{Area inside of insulation} = \frac{6.62 \times 3.14}{12} = 1.73 \text{ sq. ft.}$$

Area outside of insulation = 3.04 sq. ft.

Arithmetic average area = 2.38 sq. ft.

$$Q = \frac{240 - 85}{\frac{2.5}{12 \times .04 \times 2.38}} = \frac{155}{2.19} = 71 \text{ B.t.u. per hour per ft. of length.}$$

For 1000 ft. of pipe the loss is 71,000 B.t.u. per hour.

CONVECTION

The flow of heat from one fluid into a metal wall and into another fluid is classed as a type of convection. The fundamentals of this manner of transferring heat are the same as for conduction except that heat is transferred through a film of stagnant fluid at the partition wall. The thickness of the stagnant films are very small but the conductivities of fluids are also small. Hence, these films act as effective insulators to the flow of heat.

Difficulty arises because the thickness of the fluid film cannot be easily measured. This difficulty is avoided by using a film transfer coefficient that is the same as the conductivity except that the thickness is always considered to be one foot. Thus, the relation between the film coefficient and the conductivity is:

$$\frac{L}{K} = \frac{1}{h}$$

The thickness of the liquid film is greatly dependent on the viscosity of the fluid and on the velocity at which the fluid passes the surface, and hence the film coefficient is also greatly dependent on the viscosity and velocity.

The flow of heat through two fluid films and a partition wall can be expressed thus:

$$Q = \frac{\Delta T}{\frac{1}{h_1 A_1} + \frac{L_2}{K_2 A_2} + \frac{1}{h_3 A_3}}$$

The areas, A_1, A_2, and A_3 are so nearly the same that it is customary to use the inside (or outside) area and an overall transfer coefficient, thus:

$$Q = HA\ \Delta T$$

$$\text{and} \quad H = \frac{1}{\frac{1}{h_1} + \frac{L_2}{K_2} + \frac{1}{h_3}}$$

EXAMPLE 28. *Heat Transfer from Condensing Steam to Water*

Steam at 240 deg. fahr. is flowing in a standard 2-in. pipe with water at 80 deg. fahr. standing on the outside of the pipe. The film transfer coefficient for the steam is 2000 and for the water 125.

How much heat is transferred per hour per sq. ft. of outside surface?

$$H = \frac{1}{\frac{1}{2000} + \frac{.3}{2 \times 12 \times 25} + \frac{1}{125}}$$

= 123.6 B.t.u. per hour per sq. ft.

A common film condition is the film of stagnant air that stands on the outside of buildings, furnaces, and insulated lines. Heat is conducted through this film by a combination of radiation and natural convection. The following equation was obtained by a study of heat losses from vertical surfaces of brick, asbestos, metals, canvas, and wood.

$$h_g = 1.5 + .0058\ (\Delta T)$$

in which:

h_g = natural convection and radiation coefficient.

T = temperature difference across the air film.

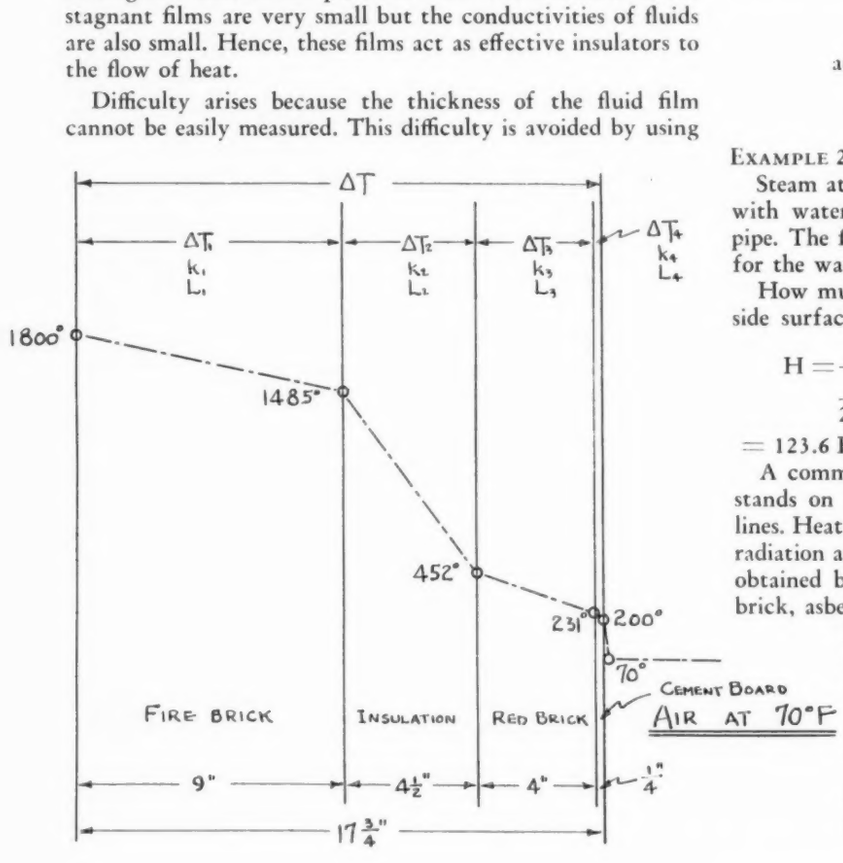


Fig. 38. Heat loss through furnace wall

EXAMPLE 29. *Heat Loss Through Bare Pipe*

Steam, at 240 deg. fahr., is flowing through a standard 6-in. pipe. The air is at 70 deg. fahr. Assume that the resistance of the steam film and the metal wall are negligible.

How much heat is lost per ft. of length per hour?

Air film coefficient:

$h_g = 1.5 + .0058\ (240 - 70) = 2.49$

Assumption, $H = h_g$:

$Q = h_g A \Delta T = 2.49 \times 1.73\ (240 - 70)$

$= 732$ B.t.u. per hour.

Note that this loss is ten times as much as for insulated pipe (Ex. 27). The complete heat transfer equation for Example 27, can now be computed by the use of the natural convection coefficient.

$h_g = 1.5 + .0058\ (85 - 70) = 1.59$

$$Q = \frac{240 - 70}{\frac{2.5}{12 \times .04 \times 2.38} + \frac{1}{1.59 \times 3.04}} = \frac{170}{2.4} = 71 \text{ B.t.u. per hour.}$$

Note that this checks the heat loss in Example 27.

A further discussion of convection will be given in Article XVIII, to be published in April.

QUESTIONS

1. What are the three methods of transferring heat?
2. Define the conductivity of a material.
3. Why are film coefficients rather than conductivities used when computing heat transfer from fluids to a metal wall?
4. Is the conduction of heat directly proportional to the temperature difference?

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2. "Elements of Chemical Engineering," Badger & McCabe, McGraw-Hill Book Co.
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New Equipment Designs and Modern Operating Methods To Be Featured at Houston Show

OFFERING the opportunity to inspect new equipment and study the latest in operating methods, the Oil Equipment and Engineering Exposition will present tools and machinery for all branches of the petroleum industry at its sixth annual show in Houston, April 8 to 13, inclusive. Equipment on display will include all types for present day operation in drilling, production, refining, and transportation. Demonstration work will be featured and wherever possible the use of equipment under actual field conditions will be shown.

Many new features will add interest to the show this year. The exhibit of new inventions will show the trend in equipment design, many of which will be displayed as working models; none as yet has been placed on the market. In contrast to these will be an exhibit of oil tools and machinery that will furnish an historical background and give the oil man an opportunity to make a study of equipment development.

The first-aid contests that aroused such great interest at last year's oil show will be even more comprehensive in scope this year.

The results of experimental work, and a display of instruments and methods used in conducting that work, will be presented by various universities specializing in petroleum engineering.

Heavy machinery will be on display in the outside space adjacent to the main exhibition building and will be shown in operation. The outside space also will be used for demonstrating how oil and gas fires are extinguished, and how such fires can be prevented.

Many entertainment features are planned. A banquet will be held featured by special entertainment and talks on matters of interest to those in the industry.

A golf tournament will be conducted under the sponsorship of the Brae-Burn Country Club. Entries for this tournament will be taken at the Exposition Building and at the Brae-Burn Country Club.

Visiting ladies of the out-of-town oil men and manufacturers will be furnished free tickets with the compliments of the exposition to a bridge luncheon sponsored by Mrs. Chase Sutton and the Brae-Burn Country Club. They also will be entertained and taken on various trips of interest.

A greater number of prizes than last year, have been provided for booth awards. In making the awards consideration will be given to whether the equipment is in operation and whether it is being demonstrated. The judges who will make final decision are: Chase E. Sutton, branch manager, Pure Oil Company; Stanley Gill, consulting petroleum engineer; E. C. Lawry, petroleum engineer, Shell Oil Company; Paul Hubbard, chief engineer, Gulf Production Company; and Bill Docherty, petroleum engineer, Humble Oil and Refining Company.

A contest will be held for salesmen and those in charge of exhibits, prizes being awarded to those who make the greatest volume of sales during the week of the exposition. In order that the contest be more equitable, there will be two divisions: one for heavy equipment, including rotaries, draw-works, engines, hoists, derricks, pumping units, and all machinery and tools of a similar nature; the other for small equipment and tools, including all specialties.

The interest of foreign oil companies in American equipment is particularly keen at the present time and E. G. Lenzner, manager of the Oil Equipment and Engineering Exposition, has been advised that a number of influential representatives will be in attendance.

Free tickets will be furnished all oil men and identifying ribbons will be given at the gate.

In addition to those whose names were published in the February issue of *The Petroleum Engineer* the following will exhibit:

American Zinc Institute, New York City; Alexander Anderson, Inc., Fullerton, Calif.; Badgett Steam Lubricator Company, Chickasha, Okla.; Big Three Welding Company, Houston, Texas; Beaver Pipe Tools, Inc., Warren, Ohio; Black, Sivalls and Bryson, Inc., Oklahoma City; Brauer Machine and Supply Co., Fort Worth; W. H. Curtin and Co., Houston; Dean Bros. Co., Indianapolis, Indiana; Double Seal Ring Co., Fort Worth; Electric Stop Nut Corporation, Elizabeth, N. J.; O. H. Holman Co., Dallas; Industrial Sales and Engineering Co., Houston; International Derrick and Equipment Company of Texas, Columbus, Ohio; Kibele Manufacturing Co., Dallas; Koenig Iron Works, Houston; Lincoln Electric Co., Cleveland, Ohio; Lucey Products Corp., Tulsa; Safety Equipment Service Co., Cleveland, Ohio; Stanley Tool and Level Plant, New Britain, Connecticut; Surety Rubber Co., Carrolton, Ohio; Transportation Equipment Co., Cleveland, Ohio; Union Chain and Manufacturing Co., Sandusky, Ohio; Vernon Tool Company, Los Angeles; F. H. Wheeler Company, Chicago; Williamsport Wire Rope Co., Williamsport, Pennsylvania; T. T. Word Supply Company, Houston.

J. B. O'CONNOR, sales manager of Clark Bros. Company, has returned to headquarters at Olean, New York, following a three weeks' tour of the oil districts of Louisiana, Texas, and Oklahoma.

EARL MILLER, president of the American Iron and Machine Works, has returned to Oklahoma City, Oklahoma, from a ten days' trip to New York City.

R. C. GRINNELL of the Fluid Packed Pump Company, Oklahoma City, Oklahoma, has recently been in Los Angeles, California, on business.

DURRELL DAVIS, formerly with the Highway Trailer Company, Edgerton, Wisconsin, is now chief engineer of the Spencer Trailer Company, Augusta, Kansas.

J. BIERMAN, vice-president of the Astra Romana Oil Company, the Rumanian unit of the Royal Dutch Shell, is in the United States on business. His headquarters are at Campina.

CARL WHITE, Jr., sales manager of the Franks Manufacturing Company, Tulsa, Oklahoma, recently completed a trip to the Gulf Coast fields.

CLARENCE J. BROWN, manager of the Merco Centrifugal Separator Company, Ltd., San Francisco, California, was a recent business visitor to the Mid-Continent.

HARRY W. TRUMP has been made district manager at Dallas, Texas. of the Industrial Division of The Timken Roller Bearing Company, Canton, Ohio. The Dallas office is at 409 Olive Street. He succeeds **J. A. ROBINSON,** who has been made district manager of the Automotive Division of the company at Chicago, Illinois.

GEORGE MORRIS, president of the Bradford Motor Works, Bradford, Pennsylvania, has just completed a business trip through the Mid-Continent fields.

RAY JENSEN, of Jensen Bros., Coffeyville, Kansas, is recuperating from a recent illness which kept him confined to his home for several weeks.

J. W. JORDAN, formerly at Tyler, Texas, for the Sinclair Prairie Oil Company, is now production superintendent for the company in West Texas, making his headquarters at Midland.

TOD PAZDRAL has been made foreman of the Dallas pipe line district for the Lone Star Gas System, succeeding **C. S. NICHOLS,** who died recently. Pazdral formerly was foreman of the Gainesville, Texas, district. **JESSE N. CARPENTER,** formerly assistant foreman at Fort Worth, has taken charge of the Gainesville territory.

FRANCISCO C. PLATZ, in charge of the division of oilfields in Commodoro Rivadavia, Argentine, South America, is in the United States on a business trip.

PAUL WAGNER, 46, staff representative of the *National Petroleum News*, and one of the most widely known oil writers of the present day, died February 24 in Houston, Texas. He had worked on the *Daily Oklahoman* in Oklahoma City and on papers in Topeka, Little Rock, Shreveport and Birmingham. He joined the *National Petroleum News* in 1917 and opened its Mid-Continent bureau in Tulsa.

R. W. McILVAIN, Sr., Chicago, vice-president and general manager of the Pure Oil Company, visited the company's offices at Houston, Texas, recently.

H. H. DRONBERGER, general still foreman at the Smiths Bluff refinery of the Pure Oil Company ar Nederland, Texas, has been transferred to the Marcus Hook, Pennsylvania, refinery. He is succeeded by **H. C. STREADL,** who has been at the Marcus Hook refinery.

ERWIN BURNS, vice-president and assistant general manager of the Baash-Ross Tool Company, Los Angeles, California, is back at his desk following an operation for appendicitis.

JOHN R. SUMAN, vice-president in charge of production for the Humble Oil and Refining Company, Houston, Texas, recently made a trip to Los Angeles, California, to attend a family reunion celebrating the golden wedding anniversary of his parents.

J. F. CORCORAN, Mid-Continent oilfield representative for the Trimont Manufacturing Company of Roxbury (Boston), Massachusetts, was in Dallas a couple of days recently on his way to Tulsa from Houston and Shreveport. He plans to leave on a trip to the Pacific Coast in April.

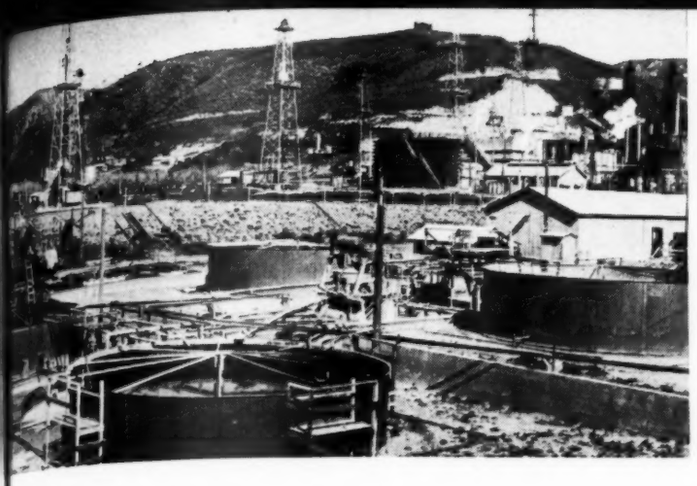
FRANK PRESTON has been made manager of the new Hutchinson, Kansas, store of the Oil Well Supply Company. He has been store manager for Oil Well at Winfield, Kansas.

ERNEST L. POTTS has been made chief engineer for the Gulf Coast district for the Eastman Oilwell Survey Company, and is making his headquarters at Houston, Texas. He formerly was with the U. S. Geological Survey at Wichita Falls, Texas.

HARRY RAUTENKRANZ, son of **CONSUL HERMANN RAUTENKRANZ** of Hannover, Germany, is at present in Texas study production methods. While in this country, he expects to spend most of his time in the field organizations of the producing department of the Magnolia Petroleum Company. His father, who is president of Krud Von Neda, the principal producer in the German oil fiels near Nienhagen, may visit the Mid-Continent fields in May.

FRANCIS S. IRVINE has joined the sales staff of the Republic Supply Company and has been assigned to the new Hutchinson, Kansas, branch store as field salesman.

C. K. WEST, of Pitzer and West, and the Chemical Process Company, Breckenridge, Texas, is confined to a Fort Worth hospital as a result of complications arising from an attack of influenza.



View of mud-mixing and reclaiming plant of General Petroleum Corporation at Ventura, California

By
J. C. ALBRIGHT

Modern Methods Employed at Central Field Mud Plant

ROTARY drilling mud now is receiving more attention than ever before. Investigations are being carried on by the oil-producing companies, the manufacturers of weight materials and bentonitic earths, and others in order that additional data may be available. Until quite recently, comparatively little attention has been given to the subject of mud reclamation. A few operating companies in California, however, have installed various types of apparatus with which the discarded mud is desanded, and in the process some of the mud is recovered. During the past year, the General Petroleum Corporation of California has made exhaustive studies of mud reconditioning, especially with regard to the desanding of mud and the recovery of weight material.

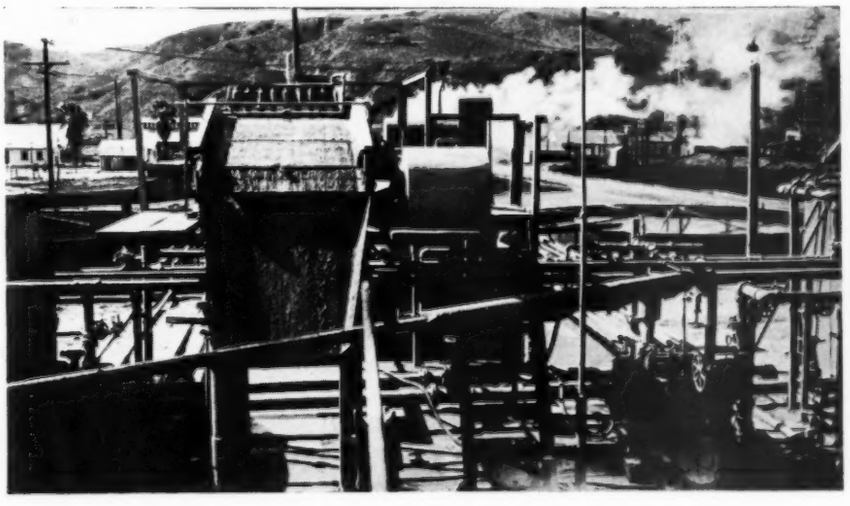
Rotary drilling mud can be efficiently mixed, conditioned, « desanded, or reclaimed »

Early in 1934, the central mud-mixing plant of this company at Ventura, California, was revamped and equipment installed that was expected to recover the barytes weight material used in making an extra heavy drilling mud. Subsequent operation of this unit has demonstrated that not only can the mud returned to the central plant from the drilling wells be reconditioned, but practically all the sand can be removed; in addition, the reconditioned drilling fluid can be classified into several grades, particularly with regard to the quantity of weight material recovered from the mud while processing it.

When drilling activity was at its height in the Ventura Avenue field, large quantities of rotary drilling mud were used. When this mud became unsuitable for further circulation it was shipped through a common system of mud pipe lines to a central sump near the mixing plant to be stored and thus prevented from being washed into the ocean and contaminating the beaches near Ventura during the rainy season. This was a costly practice, for often a supply of fresh rotary mud would be prepared and shipped through the system of mud lines back to the well location, only to become unsuitable in, perhaps, a few hours and then be discarded for an additional supply of fresh mud.

These large sumps for discarded rotary drilling are in reality large slush pits. One such is 76 ft. wide, 132 ft. long, and about 15 ft. from the top of the retaining wall to the bottom, and has a capacity of approximately 150,000 cu. ft. of mud. The discarded mud in this sump carried the finely divided cuttings, some of the colloidal matter originally in the mixture, and some of the original weighting material. With drilling mud costing about $3.00 per bbl., the value of the mud contained in the sump, when expressed in dollars and cents, is quite large.

Fortunately for the oil operators in California, there are several deposits of desirable clays that possess the qualities required for rotary drilling mud, particularly the colloidal matter contained in them. Drilling mud from these clays is adequate for shallower drilling where gas pressures are not



View showing vibrating screen, which is 60-mesh. All mud passing through the plant from wells is processed through this unit before going through the centrifugal separator

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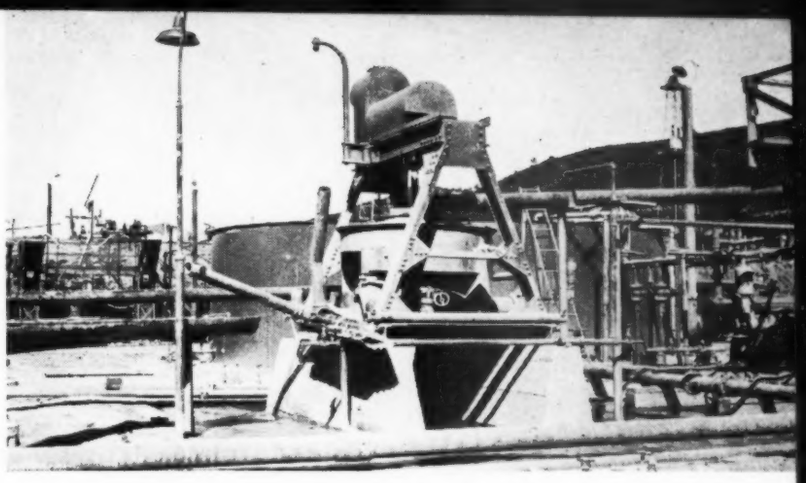


Centrifugal separator reclaiming machine, which also may be used as a desanding unit, or in recovery of Baroid from drilling mud rejected by wells

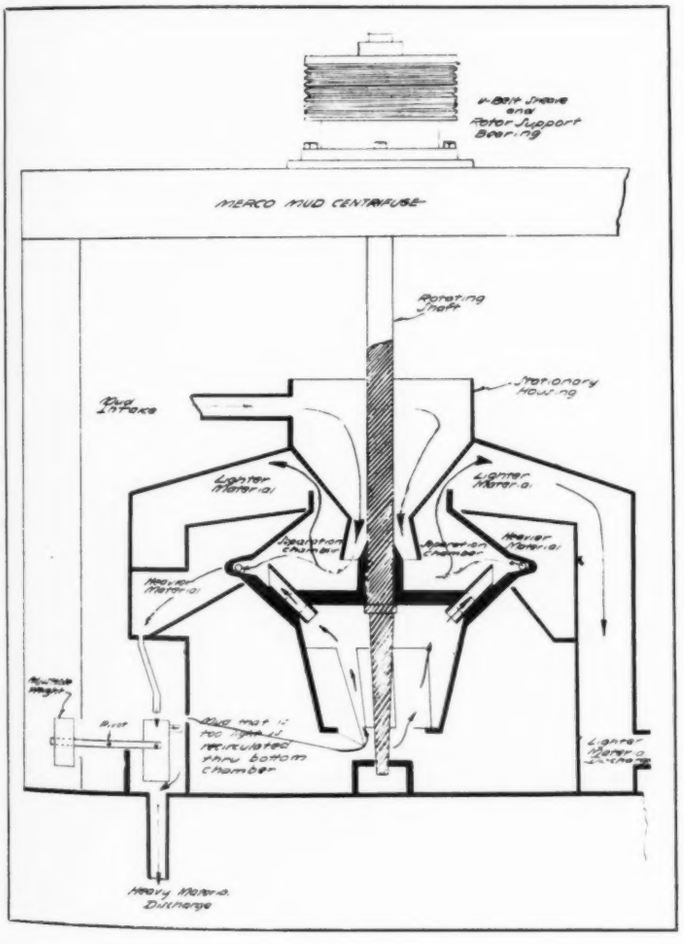
high, but as the wells are completed at a greater depth, it is necessary to add other ingredients to this natural mud in order to maintain a proper hydrostatic head, and to assist in sealing the formations penetrated while drilling. Mojave clay from dried lake beds is used in this field as the base material in preparing rotary drilling mud, as it contains an adequate amount of colloidal material for shallow wells where the formations are not too porous; but in wells 7000 and 8000 ft. deep, as some are in the Ventura Avenue field, it is necessary to add barytes and bentonitic clays to the mud to obtain satisfactory results. Even with all the precautions used in mixing the mud to the proper weight and gel-forming qualities, often the circulating mud is contaminated by pockets of gas encountered and must be returned to the central plant for reconditioning and degasifying.

The central mud-mixing plant built by General Petroleum Corporation was placed in service primarily to relieve the operators at the wells from the duties of mixing, and also in order that the petroleum engineers could keep a closer check on the amount of gel and weight material required for any particular well or operation. The original plant was concerned only with the mixing and blending of rotary drilling fluid, and to accommodate the raw or semi-finished material, together with the special barytes and bentonite, a long building was constructed consisting of two rooms with a hallway between. In the hallway a heavy slush pump was placed for circulating and agitating the mud being mixed in a concrete pit near by. The Mojave clay was stored in one end or room of the building, and the other materials in the other room. A special hopper was built near the concrete pit to enable the operator to feed the clays and other material into the pit so it could be rapidly and thoroughly mixed to the desired consistency. Ordinarily, an initial mixture of 100 bbl. is prepared at one time, using the Mojave clay as the base, to which, after it was thoroughly mixed with the necessary amount of water to obtain the desired viscosity and consistency, the necessary volume of weight material was added. Various weights of mud are used, ranging from about 75 lb. (8.6 lb. per gal.) per cu. ft., to 95 lb. (12.6 lb. per gal.) per cu. ft., depending upon drilling conditions and bottom-hole pressures encountered.

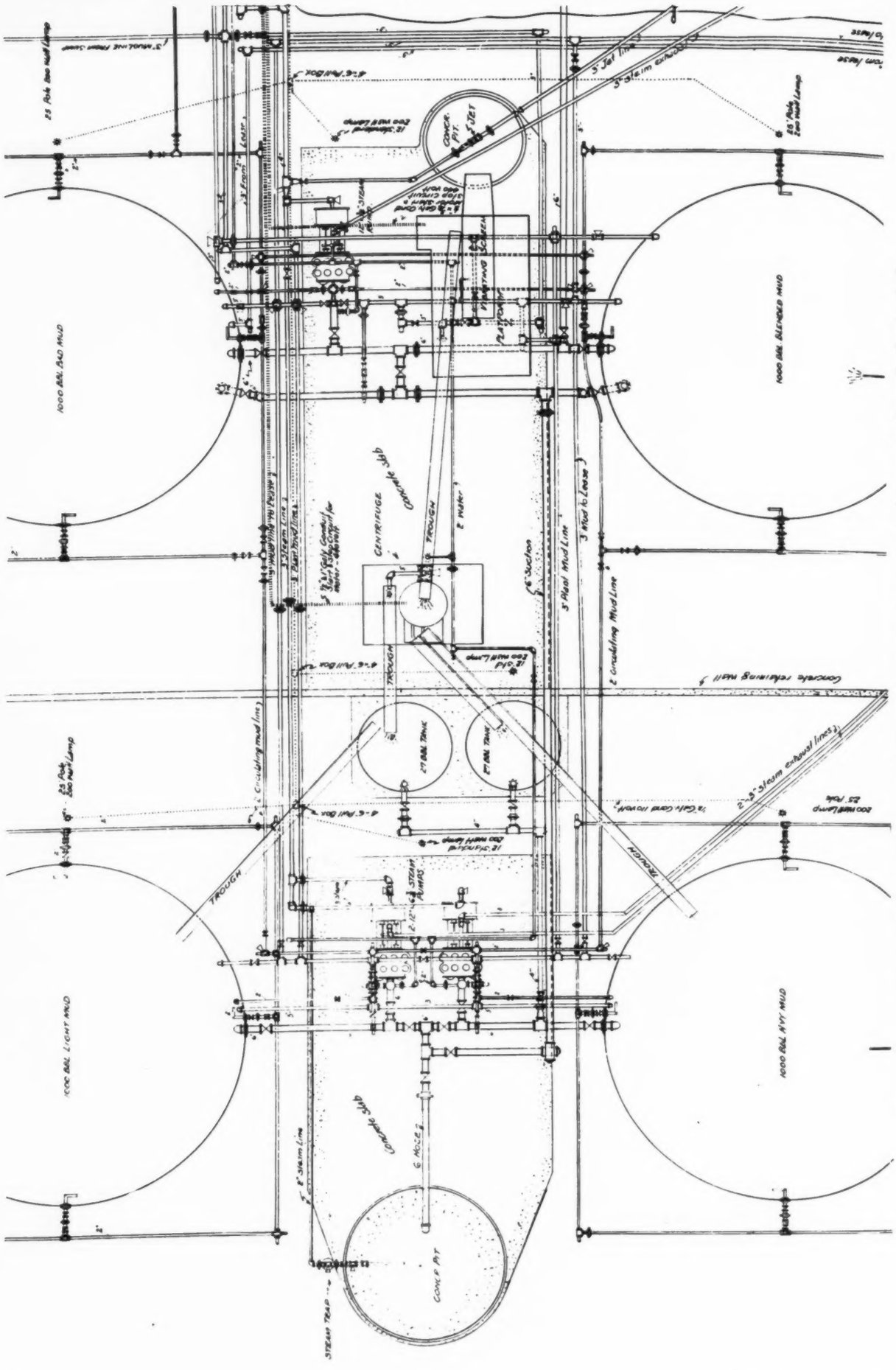
This mud was stored in 1000-bbl. steel tanks, each tank containing a differently mixed mud, which was transported through the pipe lines to the drilling wells as needed. When it became unsuitable for continued circulation, it was promptly pumped back to the common sump and not used in drilling again. When apparatus was designed that could be used in reclaiming rotary drilling mud, a unit was installed in the mud-mixing plant at Ventura. Mud that is received from the drilling wells is now placed in the "bad-mud" tank, after passing through the vibrating screens at the wells, which remove all the large particles of shale cuttings and most of the coarser sand. It still contains a percentage of fine sand that must be removed before it can be classified into the different grades of reclaimed mud.

The new apparatus consists of two units, the first of which contains a vibrating screen through which the mud must pass to remove the sand and finely divided shale cuttings. Several pumps are used in the mud plant to handle the fluid and to ship it back to the wells after it has been reconditioned. These pumps are reciprocating steam-driven units, each having 12-in. by 6¾-in. fluid cylinders. One pump, set between the "bad-mud" tank and the tank containing the blended material, handles the mud after it has been returned to the plant from the well. It is picked up through a 6-in. line and discharged to the feeder above the vibrating screen in the desanding unit.

The desanding machine, fitted with a 60-mesh screen, removes practically all the sand. That passing through the screen is finer than 150-mesh, and may be removed in the second unit if found desirable; however, the mud returned from the wells contains only about five per



Cross-section of the centrifugal separator type of mud desanding and reclamation machine used by General Petroleum Corporation at its Ventura Avenue central mud plant



General arrangement of screening and desanding equipment at the central mud plant of the General Petroleum Corporation in Ventura Avenue field, California

cent of sand, and approximately 80 per cent of that is removed in the vibrating screen unit. The capacity of the reclamation plant is governed largely by the amount of sand in the mud being processed, which in turn determines the speed with which it may be pumped through the plant. Mud that has fair fluidity and containing a small percentage of large grains can be passed through more rapidly than a mud of lesser fluidity, which may have a tendency to ride on the vibrator and not pass through readily. With an average mud, approximately 320 bbl. can be passed through the screen in 5½ hours' working time. The sand removed over the screen falls from an apron into a small concrete-lined excavation and is jetted from it as it becomes filled.

The desanded mud is transferred by gravity from the vibrating unit to the second machine, where the finely divided particles may be subsequently removed, or the mud classified according to weight. This second unit is a centrifugal separator operated by a 15-hp. electric motor at a speed of 540 r.p.m. It is built of steel, set on a concrete foundation sufficiently high that the material coming from it may also be transferred by gravity to the tanks desired. This unit is made with a stationary housing containing the rotor and the directing baffles. The rotor itself is made in the shape of a bowl, hanging in the stationary housing on its driving shaft, which rests on a single bearing at the top of the structure. The bowl contains twelve nipples, or jets, placed in the outer rim through which the heavy material passes when in operation. (See accompanying illustration on page 101 showing cross-section of the centrifugal separator.)

Mud that has been desanded enters through the mud intake at the top of the stationary housing and passes through a venturi throat down into the rotating bowl. The speed of the rotating bowl causes the heavier parts of the mud to be thrown to the outer surface, and as it passes through ports opposite the nipples it enters the lower chamber of the stationary housing. The lighter material rises to the top of the bowl, outside of the venturi throat and is drawn away through the upper compartment of the housing. It passes out through a take-off line and flows to the tank selected to receive it. To control the weight of the heavier material separated from the mud, a weighing device, placed in the unit, may be adjusted to prevent any material passing through the heavy material discharge before it reaches the desired condition.

This weight indicator and control apparatus are built similar to a bucket with a return nipple resting opposite a port in the lower part of the housing. As the heavy mud, sand, or weight material separated must travel through a pipe reaching down into the bucket, it will return to the chamber if it is not heavy enough to trip the control apparatus. Returning through the port, it is picked up again through the opening in the lower part of the rotor and further divided into light and heavy material until it reaches the point where the weight is sufficient to operate the bucket. When this stage is reached, the bucket lowers until the port in the housing is closed and the material overflows and runs out the heavy material discharge. The bucket may be set to any desired point by adding additional weights to the arm, or adjusting the weight to a point farther out, depending upon the grade of material desired to be separated through the lower outlet.

The unit is so constructed that it may be used as a desander alone, with the drilling mud flowing out through the upper outlet, and the sand remaining in the lower compartment of the housing, or until it is removed through the bucket, or drawn away through a cleanout line. When used as desander only, the weight on the bucket arm is adjusted to a point to retain any material in the case that weighs in excess of 115 or 120 lb. per cu. foot. With this method of operation, the drill-

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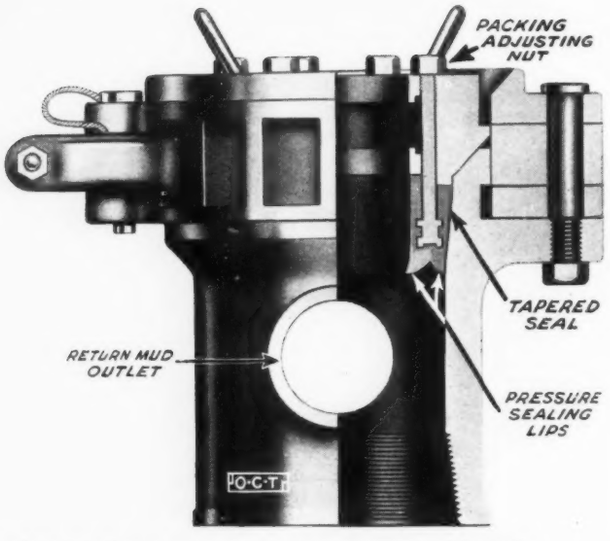

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This strong compact wiper is designed to fit *all* LUFKIN Oil Gagers Tapes. Can be attached to tapes now in the field, or to obtain it on new tapes, order them "With 599 Wiper." Small pads, on which the tension is regulated by a thumb screw, wipe oil from line as it is being rewound.

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THE LUFKIN RULE CO.

SAGINAW, MICH.

ing mud is prepared as a desanded product only, and contains all the water, bentonite, and barytes returned from the well.

If found necessary or desirable to rerun the desanded material to recover the weight material, such as barytes, it is put through the machine again, and the weight apparatus set so the desired portion of the mud is discharged from the bottom outlet where the sand was removed in the previous operation, and the lighter mud taken from the upper outlet, and containing as much or as little of the weight material as desired. The rotor, or centrifugal unit of the machine, is set so that if one of the nozzles should become clogged or broken, it will throw the machine out of balance, causing the whirling suspended part to vibrate, and when this occurs, a switch is opened that cuts out the current entering the motor drive.

A representative day's reclamation shows that when a 320-bbl. batch of discarded drilling mud was received from the wells at the plant, it could be desanded through the vibrating screen unit and classified within a period of 5½ hours. This particular mud had a weight of 84 lb. per cu. ft. (11.23 lb. per gal.) and a funnel viscosity of 23 seconds. In running it through the desander and the separating machine, 40 bbl. of 97-lb. mud was reclaimed, together with 140 bbl. of 95-lb. mud. This operation showed a recovery of approximately 56 per cent of the original batch. Taking an average month, at the present time when drilling is not so active as formerly, an average of 125 bbl. was recovered daily. This amount, which had been placed in the sump before the installation of the recovery unit, represents a considerable saving. If drilling mud is costing about $3.00 per bbl., base clays, barytes, bentonites, etc., included, the monthly saving due to the operation of the plant is approximately $11,000.

The large sump containing the drilling mud discarded during former drilling operations is being worked over during days when current mud is not received too often. It has been found that by jetting water into the sump and recirculating, it can be mixed to a consistency that is fluid enough to be desanded and classified as drilling mud. Some of it may not contain sufficient barytes and bentonite clays to make it a desirable mud for deep wells, but with an addition of the necessary amount of these ingredients, it will justify rerunning and using for circulating fluid in wells in which gas pockets at shallow depths are not anticipated. The heavier material classified from the lower outlet of the machine when rerunning current mud is considered as valuable as freshly-mixed material, and is used in the deepest wells being drilled.

Lane-Wells Company Opens Tulsa and Oklahoma City Offices

W. T. Wells, president, announces that offices have been opened in Tulsa and Oklahoma City, Oklahoma, by the Lane-Wells Company, Los Angeles, California, manufacturers and operators of the new type gun perforator for penetrating casing in wells. This makes their perforator service available at all points in Oklahoma, Kansas, Arkansas, New Mexico, and northern Texas. In addition to these two offices and the general headquarters and plant in Los Angeles the company has offices at Houston, Texas, and New York City. The Tulsa address is 327 Philcade Building, and that at Oklahoma City, 1321 South Walker Street. C. E. Wells is district manager.

Correction

In the footnote on page 56 of the February issue of *The Petroleum Engineer*, Baroid, an important mud-weighting product, was inadvertently omitted from the list of products shown and should have appeared as follows:

Baroid—Baroid Sales Company, Los Angeles, California.

E. S. Dickey Made Executive Representative American Meter

E. S. DICKEY

The American Meter Company has announced the appointment of E. S. Dickey to the position of executive representative. He will maintain his present address at the American Meter Works office, 309 East Saratoga Street, Baltimore, Maryland.

The creation of this new post marks another step in the company's current program to perfect and strengthen its customers' service and sales organization simultaneously with modernization and consolidation of plant and manufacturing facilities. The suspension of production activities in the Baltimore factory will enable an experienced executive and practical engineer such as Dickey to devote more of his time and interest to the active requirements of gas company customers, particularly those he formerly served in his capacity as manager of Maryland Meter Works.

C. P. Boone Made Manager Wire Sales on Pacific Coast for U. S. Rubber

C. W. Higbee, sales manager of United States Rubber Products, Inc., Wire Division, announces the appointment of C. P. Boone as manager of the company's wire sales on the Pacific Coast. Mr. Boone will have his headquarters at the company's branch in San Francisco, where he will work under Harry M. Green, manager of Pacific Coast branches.

Upon graduation from the College of Mining, University of California, in 1906, Boone joined Charles Butters and Company, Ltd., London, England, working out of their San Francisco branch. He maintained this connection until 1917, during which time his work as a metallurgical engineer took him to Mexico, Central America, South America, and India.

During the next three years he established an office of his own in San Francisco as consulting engineer, and in 1920 returned to his former firm, who sent him to Los Angeles on a three years' mission. In 1923 he became interested in oil mining and followed this career until he made his present connection.

American Steel and Wire Company Opens New Tulsa Warehouse

To better serve its customers the American Steel and Wire Company has opened a new warehouse at Elwood and Archer streets in Tulsa, Oklahoma. A complete stock of oil country wire lines, representing an initial investment of $200,000, is being carried. J. V. McGinity is district manager with offices at 217 Atlas Life Building, Tulsa.

Ralph H. Clore is Dead

The many friends of Ralph H. Clore, general sales manager of The Medart Company, St. Louis, Missouri, will be grieved to learn of his death on March 6.

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The KEY to LOWER LIFTING COSTS
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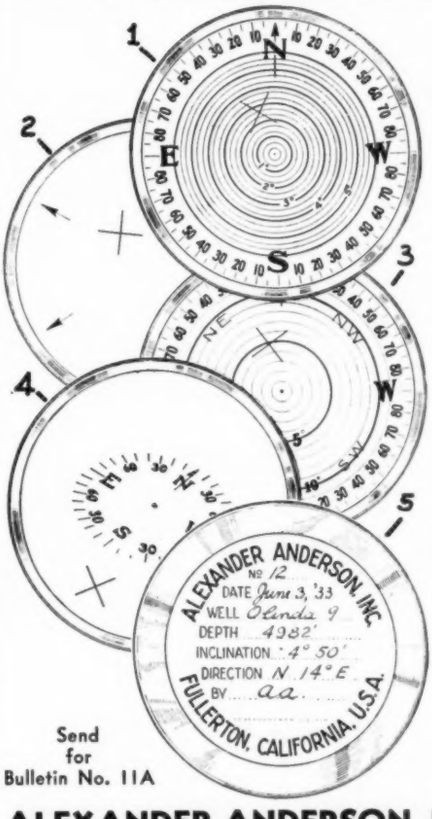

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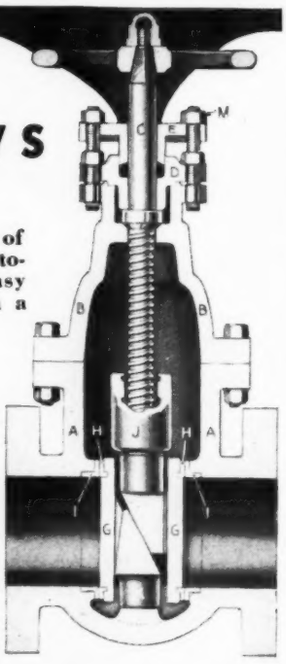

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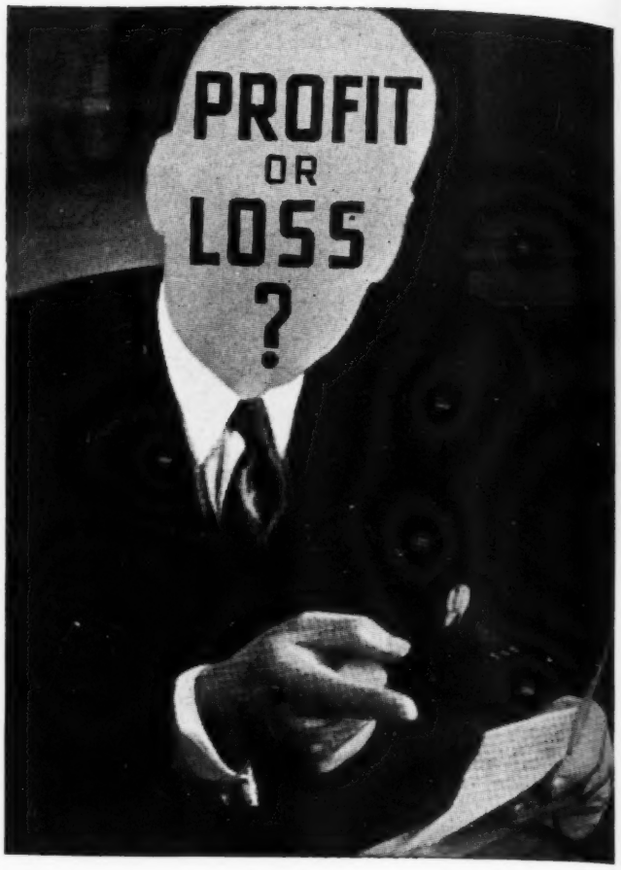

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Bridgeport Opens Dallas Office

The Bridgeport Machine Company, manufacturers and distributors of rotary and cable tools, tubular products and oilfield supplies, has opened a new sales and service office in

downtown Dallas. The new quarters are located on the 14th floor of the Magnolia Building and are being established to increase the efficiency and convenience of the company's service in Texas, where distributing points are maintained at Houston, for the Gulf Coast territory; at Kilgore, for East Texas operations; and at Pampa, to serve the Panhandle, besides various yards and branch stocks in other active sections of the state. Orders received at the Dallas office are dispatched to the nearest stock point for fulfillment, adding considerably to the convenience of the company's customers in Dallas and vicinity.

In the accompanying illustration are shown: F. R. House (left), manager of the office. Fred Parks (right), Texas state manager, also headquarters at Dallas. Miss Werdna Moon (insert), is the office secretary. The local telephone number is 2-4282; long distance number is 548.

Clyde Graham Joins Sales Staff Oil Center Tool

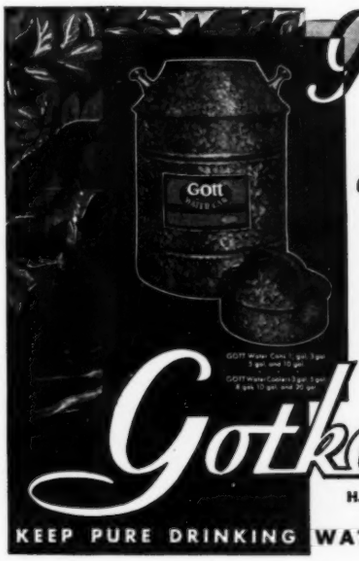
CLYDE GRAHAM

Oil Center Tool Company, Houston, Texas, announces the addition of Clyde Graham to the O-C-T sales force in the Gulf Coast territory. Graham is well known through the fields of Texas and Louisiana, having been identified with the industry since 1919, when he began roughnecking for the Humble Oil and Refining Company. He represented Lucey Products Corporation in the Gulf Coast several years, and comes to Oil Center Tool Company from the Circle "W" Oil Company.

Jarecki Opens Store at Russell, Kansas

The Jarecki Manufacturing Company has opened a new branch store at Russell, Kansas. Jess Hunt, transferred from Eldorado, Kansas, is field salesman, and Gene Hollis, transferred from Borger, Texas, store manager.

H. R. Carpenter, Bartlesville, Oklahoma, district manager of the Jarecki Manufacturing Company, has spent considerable time in Kansas recently, accompanied by George Harrington, sales engineer for Hewitt Rubber Corporation.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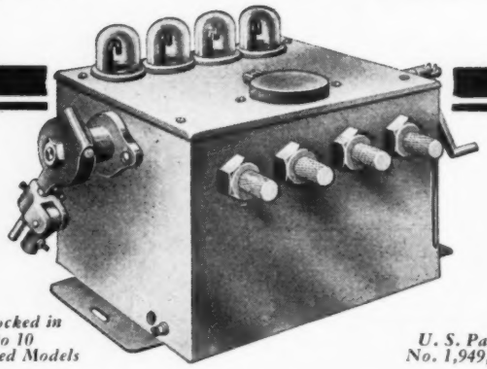

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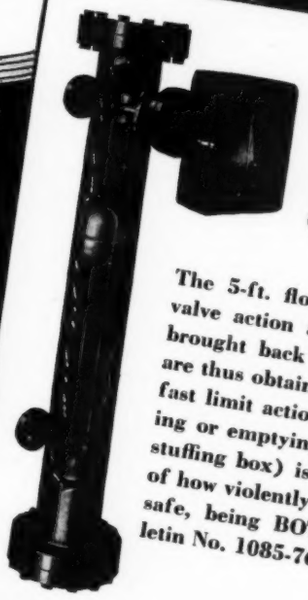

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